

# **Marshall Space Flight Center**

## **Microgravity Strategic Plan**

### **A PLANNING EXERCISE**

Prepared by

**The Center for Space and Advanced Technology**

**In Fulfillment of Contract NAS 8-38669**

**15 April 1991**

(NASA-CR-1990-21) MICROGRAVITY STRATEGIC  
PLANNING EXERCISE Final Report (Center for  
Space and Advanced Technology) 109 p

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## ABSTRACT

The Center for Space and Advanced Technology supported a planning exercise for the Microgravity Program management at the Marshall Space Flight Center. The effort focused on the status of microgravity work at MSFC and elsewhere with the objective of preparing a goal-oriented strategic planning document which could be used for informational/brochure purposes.

The effort entailed numerous interactions and presentations with Field Center programmatic components and Headquarters personnel. Appropriate material was consolidated into a draft format for a MSFC Strategic Plan.

Summary of CSAT Activities and Events Related to the Completion of  
Contract NAS 8-38669, MSFC Microgravity Strategic Plan

The following is a brief summation of the highlights of the activities performed by the Center for Space and Advanced Technology (CSAT) personnel during the period of performance on Contract NAS 8-38669, MSFC Microgravity Strategic Plan, for the Spacelab Payloads Project Office (SPPO). Frequent meetings occurred between CSAT and MSFC personnel between July 1990, the Contract start date, and April 1991, the Contract completion date; therefore, these meetings are not singularly noted below:

- Contract NAS 8-38669 initiated in July 1990
  - Initial effort was directed toward producing a Centerwide Strategic Plan for Microgravity under the direction of the SPPO.
  - Kickoff meeting held between CSAT and SPPO director, microgravity chief and COTR at MSFC, Where CSAT's outline of proposed activities (Attachment 1) was presented and accepted.
- Participated in bi-weekly and monthly coordination meetings established by SPPO with Program Development and Space Sciences Laboratory for purpose of understanding total MSFC program activities in microgravity.
- Contract modification (Modification 1) prepared in August 1990 to provide additional effort requiring assessment of documentation relevant to information systems and data management needed to transition from Shuttle/Spacelab payloads to Space Station Freedom payloads.
  - Prepared logical approach (viewgraph format) for presentation of OSSA requirements to SSF program office. (Attachment 2).
- Initiated interviews at NASA Headquarters and at MSFC with cognizant Government personnel to insure compliance with the

OSSA Strategic Plan, the MSAD Strategic Plan and the MSFC Strategic Plan.

- As part fulfillment of Modification 1, participated as a key member of the Code S/Code M Mode Team that assessed the SSF Data Management System. Provided critical inputs to the development of a white paper describing OSSA information systems requirements on the SSF.
- At a meeting of 13 November 1990 between CSAT and Harry Craft, Dr. Tandberg Hanssen and all the principals from the MSFC side, received an action item to prepare a presentation performing a complete management assessment including manpower and funding at MSFC related to all Center microgravity programs, prior to proceeding with the Strategic Plan. Presentation scheduled for December 1990.
  - As a result, CSAT requested and received a no-cost extension of its Contract to March 31, 1991.
- Presentation made on 19 December 1990 to Dr. Tandberg Hanssen, Dr. Fichtl, Dr. Snyder and Mr. Bass of SSL; Mr. Craft, Mr. Marmann, Mr. Stone, Mr. Jex, Mr. Chassay and Mr. Bean of SPPO; and Mr. Taylor of PD. (Attachment 3)
  - Subsequently, Mr. Craft requested assistance in providing data and analysis for a briefing to be made to Center management. A set of charts from which Mr. Craft could obtain supporting information for his presentation was prepared and delivered. (Attachment 4)
- Participated in several meetings with the Acting Deputy Director of OSSA MSAD to discuss SSF restructuring and its effect on the microgravity science program in the area of information systems. Contract work under Mod 1 terminated as of March 31, 1991.
- Draft of Strategic Plan prepared and presented to Mr. Craft and Mr. Stone during the week of 1 Mar 1991. (Attachment 5) Due to desire

for extensive coordination review by Mr. Craft, CSAT requested and received a second no-cost extension of the Contract to 30 April 1991.

- Subsequent to extensive review, the final version of the proposed MSFC Microgravity Strategic Plan is hereby formally submitted as Attachment 6 completing all deliverables required by Contract NAS 8-38669, including the modification.

**Draft of MSFC Microgravity Strategic Planning Exercise**

- Synopsis of OSSA Strategic Plan
  - Must adapt same or similar approaches to decisions
    - Establish a set of programmatic themes
    - Establish a set of decision rules
    - Establish a set of priorities for missions and programs within each theme
  - Demonstrate that the strategy can yield a viable program
  - Check the strategy for technology readiness and for consistency with resource constraints, such as budget, manpower, facilities, and and launch vehicle availability
- Synopsis of MSAD Strategic Plan
  - MSFC Strategic Plan to "take off" where MSAD Plan ends
  - Consider existing constraints, both programmatic and funding
- Synopsis of current MSFC MSAD-funded activities
  - Flight Projects
    - Contracts
  - Ground program
    - Grants
  - Science program (SSL work)
    - Director's discretionary fund projects
  - Status of above tasks
- Strengths and weaknesses of current MSFC MSAD-funded activities
  - People
    - Technical capability
    - Scientific reputation

- Management skill
  - Organization
    - Formal and informal
    - Internal to PPO
    - External interfaces within MSFC
      - Project Development
      - Procurement
      - S & E support
      - Director's Office
    - External interfaces within Agency
      - Headquarter's offices
      - Code S
      - Code SN
      - Other MSAD Centers
    - Communication channels
    - Facilities
      - Fabrication
      - Test
      - Ground Simulation
      - Flight carriers
- Building the Strategic Plan
  - Choose starting date
  - Select appropriate duration for Plan
  - Project desired budget levels based on stated "objective" analysis of what is probable in selected time frame
  - Based on strengths and weaknesses above, decide where PPO thinks it wants to be
    - Determine what is needed to get there and price out



- Review within PPO
  - Do desires, manpower and funding levels match?
  - Rework as necessary
- Begin external review
  - Do PPO desires match Center projections and commitments? Headquarters?
  - Do PPO desires impact other Centers' objectives?
- Begin process of advocacy for program



*Engineering and Sciences Division*

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# **Microgravity Science and Applications Division**

## **Approach to Implement Visual Requirements**

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**DRAFT**

**R. Golden**  
**Sept. 1990**

# **Agenda**

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- **Space Station Freedom Data Management System (DMS) Issues and Concerns**
- **Objective of Visual Processing Effort**
- **Approach for Implementation**
- **Reasoning Behind Approach**
- **Summary**

# **Issues and Concerns**

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- **Level II withdrawal of image processing change request (CR)**
- **Removal of 1 Gbps requirement throughout remaining Level II CR's**
  - Incorporation of electronic switch CR would only account for 100 Mbps
  - Users responsible for development of >100 Mbps transmitters and receivers
- **Lack of ZOE and payload data storage**
- **"Charging" of resources for DMS hardware to users**
  - 7 MDM's allocated to users
  - Users must purchase high rate transmitters and receivers
  - Users must purchase DMS LAN interface equipment
  - Users "discouraged" from providing dedicated (non-SDP) processor

# Objective

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- **Define near-term (through 2000) set of OSSA visual requirements**
  - Factor in SSF budget and resource restrictions
  - Does technology exist to accommodate requirements?
- **Encourage Space Station Freedom Program to perform full impact assessment of incorporating OSSA visual requirements into the data system design. Put aside the issue of who will provide the capabilities**
  - Image Processing
  - High Rate Transfer (1Gbps)
  - Data Storage
- **Design, develop and implement a visual system that meets near-term requirements, but provides the flexibility to evolve and expand to incorporate visual technology advances as the budget allows. This provides a growth plan to meet longer term user visual requirements**

# **Approach**

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- **Internal OSSA working group define visual requirements**
  - Consolidated OSSA position
  - No longer discipline science requirements
- **Develop, initiate and champion SSF CR requiring incorporation of OSSA visual requirements**
  - "MODE" team activity or other SSF working group
- **Solicit support of CR from other NASA codes and partners**
  - ESA presently performing visual processing study
- **Support work packages in performing impact assessments of CR**
  - Stress that issue of who pays for funding and resources will be resolved post-assessment
  - Effort should focus on what, where, how, and how much.....not who
  - Recommendations should be excluded
- **Support SSF in accumulating present weight, volume, power, and funding budgets for equipment that will be modified and/or replaced with implementation of the CR**
- **Perform delta analysis so that trade-offs can be made by the appropriate people**

## Reasoning

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- SSF Program recognizes user visual requirements are valid but does not have the resources to accommodate them
- CR evaluators would perform impact assessments to same set of requirements resulting in high integrity of outcome
  - "Apple vs. apple" comparisons can be made
  - Sanity check
- The appropriate user and SSF representatives would have the information necessary to make trades between costs, resources, and capabilities
- Even if users provided much of the visual processing capabilities, the Station would still be impacted in the area of special rack accommodations

# Summary

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- Program and users alike would know exactly what implementation of user visual requirements would cost in terms of money and resources
- If properly completed, the user community would finally feel as if SSF considered their visual requirements
  - Users requirements would be fully assessed and O SSA would either have to "put up or shut up" and subsequently support the SSF visual system capabilities



ATTACHMENT 3

**MICROGRAVITY STRATEGIC PLAN**

**CENTER FOR SPACE AND ADVANCED TECHNOLOGY**

**DECEMBER 19, 1990**

**MICROGRAVITY STRATEGIC PLAN  
MANAGEMENT ANALYSIS**

**MICROGRAVITY STRATEGIC PLAN  
MANAGEMENT ANALYSIS**

**AGENDA**

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<b>INTRODUCTION</b>	<b>DOWNEY</b>
<b>HEADQUARTER'S PERSPECTIVE</b>	<b>HALPERN</b>
<b>RESOURCES/MANAGEMENT ANALYSIS</b>	<b>SNEED</b>
<b>PREVIOUS RESPONSIBILITIES AND POSSIBLE CONSIDERATIONS</b>	<b>DOWNEY</b>
<b>GOALS AND OBJECTIVES</b>	<b>DOWNEY</b>

## INTRODUCTION

BACKGROUND  
NASA/MSFC MICROGRAVITY PROGRAM ANALYSIS AND STRATEGIC PLANNING

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- SSL (NAWMANN) DRAFTED "MSFC STRATEGIC PLAN FOR MICROGRAVITY RESEARCH"  
(UNPUBLISHED)
- NASA ISSUED A "MICROGRAVITY STRATEGIC PLAN - 1990"
- HARDY & ASSOCIATES, INC ACCOMPLISHED A STUDY, "AN ANALYSIS OF MSFC'S  
MICROGRAVITY MATERIALS PROGRAM" COMPLETED IN 1990
- CSAT AWARDED CONTRACT TO DEVELOP MICROGRAVITY STRATEGIC PLAN FOR MSFC

## SUMMARY RECOMMENDATIONS OF COMPLETED CONTRACT

### AN ANALYSIS OF MSFC'S MICROGRAVITY MATERIALS PROGRAM

- OSSA'S MICROGRAVITY PROGRAM ADOPT THE TRADITIONAL APPROACH OF COMPETITIVELY SELECTING PRINCIPAL INVESTIGATORS FOR SPACE FLIGHT INVESTIGATIONS.
- IN THOSE CASES WHERE IT IS DEEMED NECESSARY FOR THE GOVERNMENT TO DEVELOP A MULTI-USER, ON-ORBIT PROCESSING FACILITY, A THOROUGH DEFINITION PHASE SHOULD BE ACCOMPLISHED PRIOR TO APPROVAL FOR DEVELOPMENT. FORMAL SCIENTIFIC INVOLVEMENT AND PARTICIPATION BY SCIENCE AND ENGINEERING LABORATORIES IS ESSENTIAL FOR SUCCESSFUL PROJECT DEFINITION AT MSFC.

NASA MICROGRAVITY PROGRAM

PARTICIPANTS

NASA PROGRAM OFFICE: OFFICE OF SPACE SCIENCE & APPLICATIONS  
OFFICE OF COMMERCIAL PROGRAMS

PARTICIPATING CENTERS

AREAS OF EMPHASIS

• MSFC

- ORGANIC AND POLYMERIC MATERIALS
- ELECTRONIC AND PHOTONIC MATERIALS
- PROTEIN CRYSTAL GROWTH

• LeRC

- COMBUSTION SCIENCE
- FLUID PHYSICS

• JPL

- DROP DYNAMICS
- CONTAINERLESS PROCESSING

• OTHERS

COMMENT - CENTER ROLES AND ACTIVITIES APPEAR REASONABLE WITH NO MAJOR  
AREAS OF UNDESIRABLE OVERLAP OR DUPLICATION.

**TOTAL MICROGRAVITY R & D DOLLARS  
R & D DOLLARS TO MSFC  
MSFC C.S. MANPOWER  
( NOT INCLUDING COMMERCIAL PROGRAM )**

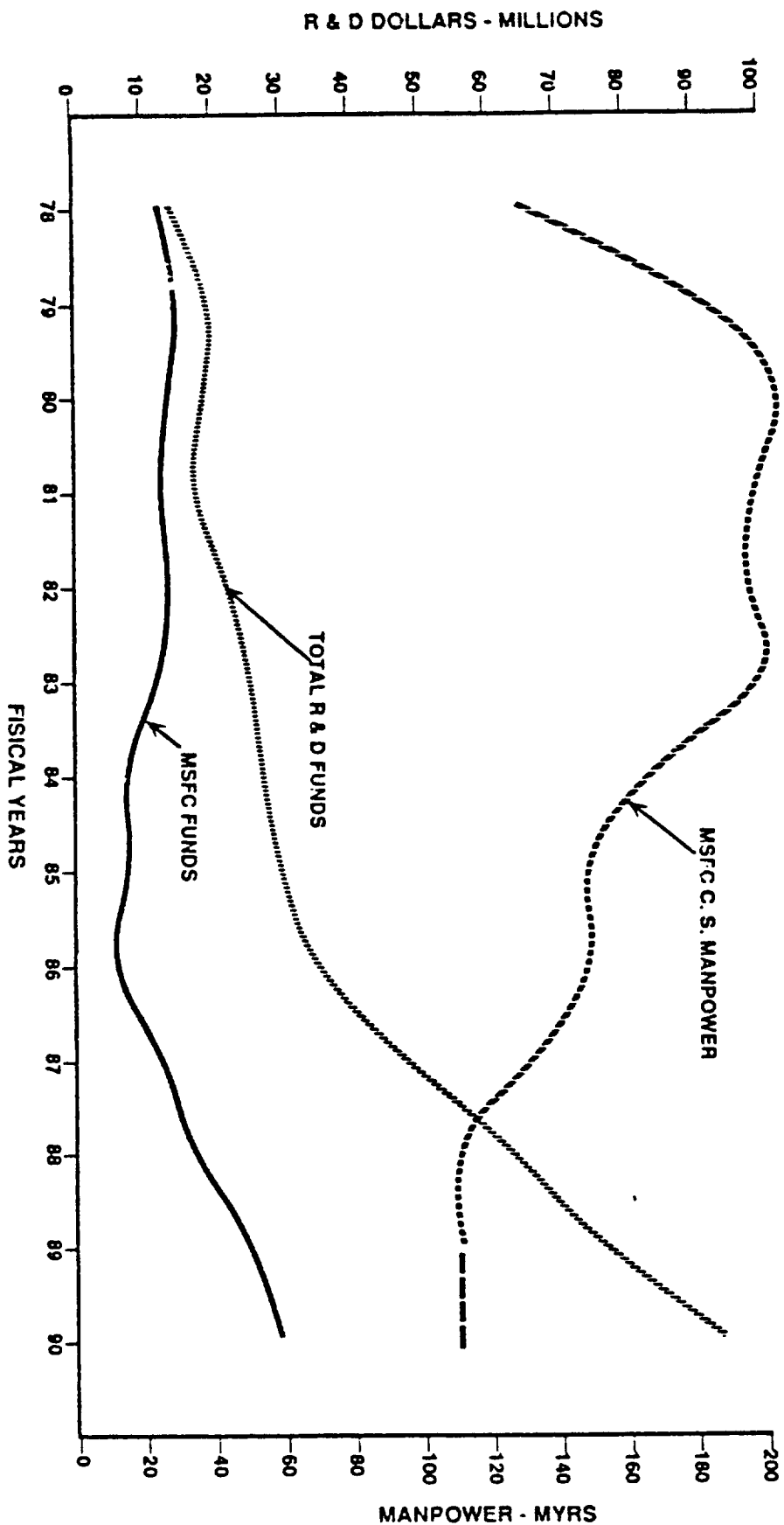


FIGURE 1



MPS FUNDS ALLOTTED BY NASA CENTER  
(DOLLARS IN MILLIONS)

NASA CENTER	FY 84	FY 85	FY 86	FY 87	FY 88	FY 89	FY 90*
JPL	6.4	4.5	7.2	11.2	20.0	14.5	19.5
JSC	1.8	2.7	2.3	2.6	2.4	2.7	3.5
LARC	0.4	1.3	1.3	1.6	2.5	3.9	4.2
LERC	5.2	5.8	7.8	11.7	14.4	20.8	24.3
NASA HQ	4.3	4.4	6.0	6.0	6.3	7.1	11.3
MSFC	7.6	8.4	6.5	14.2	17.2	26.5	29.7
TOTAL	25.7	27.1	31.1	47.3	62.8	75.5	92.5

\* DATA PRIOR TO FY 90 ADJUSTMENTS

HEADQUARTERS PERSPECTIVE

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MSFC MICROGRAVITY PROGRAM  
A HEADQUARTER'S PERSPECTIVE

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• PEOPLE INTERVIEWED:

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-- SCHMITZ  
-- KICZA  
-- CROUCH  
-- KEARNS  
-- SCHMOLL  
-- RHOME  
-- BENSON

• GENERAL OVERVIEW:

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-- NOT FAMILIAR WITH RECENTLY INITIATED COORDINATION WITHIN MSFC; DELIGHTED  
TO HEAR IT AND HOPE IT CONTINUES

-- MSFC AREAS OF ACTIVITY, I.E., CRYSTAL GROWTH, POLYMERS, BIOTECH,  
CONSISTENT WITH MSAD PROGRAM

-- WILLING TO OPEN UP NEW AREAS, IF THERE IS SUFFICIENT SCIENTIFIC IMPETUS.  
E.G., FLUIDS

-- MSAD PREPARING NEW SCIENCE PLANNING DOCUMENT; MSFC WILL NEED TO CONSIDER  
IN ANY STRATEGIC PLAN

MSFC MICROGRAVITY PROGRAM  
A HEADQUARTER'S PERSPECTIVE

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(CONTINUED)

• GENERAL OVERVIEW (CONTINUED)

- MSAD CONTINUES TO EMPHASIZE MULTI-USER FACILITIES WITH SPECIFIC P. I. MODULES
- MSAD EXPECTS INCREASED INTERNATIONAL COOPERATIVE PROGRAMS; MSFC MAY WANT TO INITIATE
- MSFC BUDGET CAN REASONABLY BE EXPECTED TO CONTINUE TO RISE; BUT PROBABLY NOT AT RATE OF PAST SEVERAL YEARS
  - MSAD BUDGET IS NOT EXPECTED TO RISE AT SAME RATE
  - COMPLETION OF ON-GOING, HIGH PRICED INSTRUMENTS
  - NEW, SOLID SCIENTIFIC PROGRAMS MUST BE STARTED TO OFFSET

MSFC MICROGRAVITY PROGRAM  
POLITICAL CONCERNS

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- DEPENDENCE ON SPACELAB AND SSE
  - MSFC MICROGRAVITY BUDGET INCREASE CURRENTLY TIED TO SSF
  - CONGRESS CONTINUES TO SUPPORT MICROGRAVITY
  - AUGUSTINE COMMITTEE APPEARS TO FAVOR LIFE SCIENCES
  - MSFC BUDGET TIED TO CONTINUED SSF EMPHASIZING MICROGRAVITY
  - UNCERTAINTY EXISTS REGARDING SSF CONFIGURATION
  - MICROGRAVITY COMMUNITY VERY CONCERNED AND BEGINNING TO QUESTION SSF UTILIZATION VICE SPACELAB, FREE FLYERS AND SOUNDING ROCKETS
  - AGENCY POSITION REGARDING SPACELAB PROGRAM CONTINUATION DURING SSF ASSEMBLY INITIATION, 1995, AND AFTERWARDS, UNCERTAIN
- EFFECT OF FEDERAL BUDGET PROCESS ON NASA FUNDING
  - BUDGET DEFICIT
  - PERSIAN GULF CRISIS

MSFC MICROGRAVITY PROGRAM  
HEADQUARTER'S CONCERNS

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- EFFORT SHOULD BE MADE TO IMPROVE COMMUNICATIONS AT ALL LEVELS - TELEPHONE CALLS, CORRESPONDENCE, VISITS
- ROLE OF PROJECT SCIENTIST SHOULD BE STRENGTHENED AT MSFC
- EFFECTIVELY PLAN AND STRUCTURE PROJECTS
- IMPLEMENT PROJECTS ACCORDING TO STRUCTURED PLAN

## RESOURCES/MANAGEMENT ANALYSIS

MSFC  
MICROGRAVITY PROGRAM ELEMENTS

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- PAYLOAD PROJECTS
- SUPPORTING RESEARCH AND TECHNOLOGY (SRT)
- COMMERCIAL PROGRAMS
- SMALL BUSINESS INNOVATIVE RESEARCH (SBIR)
- CENTER DIRECTOR'S DISCRETIONARY FUND (CDDE)



# PAYLOAD PROJECTS

## • SCOPE:

- FLIGHT EXPERIMENTS
- PRINCIPAL INVESTIGATOR SUPPORT
- MISSION SUPPORT
- FLIGHT HARDWARE DEFINITION & DEVELOPMENT

## • RESOURCES:

	FUNDING	MANPOWER		
		CS	SC*	TOTAL
	(NOA GUIDELINES)			
-- FY 90 (actual)	\$ 33,222	103.0	5.0	108.0
-- FY 91	26,429	106.8	5.0	111.8
-- FY 92	25,853	100.0	5.0	105.0
-- FY 93	28,272	100.0	--	100.0
-- FY 94	25,787	75.0	--	75.0
-- FY 95	22,350	75.0	--	75.0
-- FY 96	24,721	75.0	--	75.0

## • MANAGEMENT APPROACH:

- PAYLOAD PROJECTS OFFICE
- OSA

\* INCLUDES UAH, STC AND SVERDRUP. EXCLUDES VISITING SCIENTISTS.

JUNE 14 11:20 A.M. POP 90-2 SUMMARY OPTION 1  
NOA GUIDELINES

ELEMENT	FY 90	FY 91	FY 92	FY 93	FY 94	FY 95	FY 96	TOTAL
FLUID PHYSICS.....								
FES/VCGS	1931	965	180					3076
FES-REFL1								0
GFPC	178	475	790	385	215	64		2107
PROTEIN CRYSTAL GROWTH.....								
PCG	1095	2250	2080	80				5505
APCGF	980	1750	3400	7557	7220	6670	7725	35302
BIOTECHNOLOGY.....								
BTF	65	100	105	112	118	124	131	755
PROJECT CONTAINERLESS.....								
ALP	2000							2000
MEL	111	200						311
SOLIDIFICATION SYSTEMS.....								
CGF USML-1	2546	3900	3000	2567	2770	2520	2900	20203
UPN 694	16800	4993	615	57	0	0		22465
UPN 412	12749	2693	245					
CGF USML-2	4051	2300	370	57				1000
SSFP		1000						
SSFP M1	666	1800	3600	7000	8300	6400	7000	34766
SSFP M3		200	2200	2000	800	400	500	6100
SCIENCE.....								
FES PI'S	715	790	579	78				2162
CGF PI'S	1069	1471	1509	1060				5109
OTHER PI'S	983	1221	1374	822				4400
MEMS	45	250						295
GLOVEBOX	160	158	166					484
GLOVEBOX INT.	85	247	164					496
ADVANCED TECHNOLOGY DEV.....								
DATA BASE	100							100
VIT	15	35						50
GRND OPS-412	93	300	600	650	700	735	750	3078
ADVANCED FURNACE		200						
ADMINISTRATION.....								
PMS (IMS)	1926	2090	2400	2520	2640	2760	2900	14336
PS	1659	2034	2791	3084	2724	2377	2500	14669
SRM&QA SUP			300	300	300	300	315	1200
TOTAL UPN 694	29078	23829	24883	27565	25087	21615	23971	154426
TOTAL UPN 412	4144	2600	970	707	700	735	750	9856
TOTAL	33222	26429	25853	28272	25787	22350	24721	164282

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# SUPPORTING RESEARCH & TECHNOLOGY

## • CONTENT:

- ELECTRONIC MATERIALS
- BIOTECHNOLOGY MATERIALS
- FLUID DYNAMICS AND TRANSPORT PHENOMENA
- METALS AND ALLOYS
- GLASSES AND CERAMICS
- GROUND EXPERIMENT INTEGRATION
- CONSULTING AND PROGRAM SUPPORT

## • RESOURCES:

	FUNDING	MANPOWER		
		CS	SC*	TOTAL
-- FY 90 (actual)	\$ 4,420 M	12.8	6.0	18.8
-- FY 91	4,233 (R)	19.5	9.0	28.5
-- FY 92	3,834 (R)	20.9	9.0	29.9
-- FY 93	2,070 (R)	20.9	9.0	29.9

## • MANAGEMENT APPROACH:

- PROGRAM DEVELOPMENT

- OSSA

(R) = REQUESTED

\* INCLUDES UAH, STC AND SVERDRUP. EXCLUDES VISITING SCIENTISTS

OFFICE OF SPACE SCIENCE & APPLICATIONS  
MARSHALL SPACE FLIGHT CENTER  
FY91 RESEARCH & TECHNOLOGY OBJECTIVES & PLANS  
SUMMARY REQUIREMENTS BY DIVISION (NOA, SE)

PROJECT	UPN	FY90	FY91 GUIDELINE	FY91 OVER GUIDELINE	FY92	FY93
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Microgravity Science and Applications Division	ES	4420	22.9 4233	19.5 0	3834 20.9	2070 20.9
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Electronic Materials		735	705	0	495	0
Electronic Materials	674-21-08	735	705	0	495	0
Casting of Solidification Semicond. Alloys	674-21-08-04	90	0	0	0	0
Modeling Directional Solidification	674-21-08-10	105	105	0	105	
Process Modelling for Materials Preparation Exp.	674-21-08-08	250	300	0	300	
Vapor Crystal Growth of Electro-optical Materials	674-21-08-11	90	90	0	90	
Growth of Zinc Selenide Single Crystals	674-21-08-06	150	210	0	0	
Solution Crystal Growth of Org. & Polymeric Mat.	674-21-08-02	50	0	0	0	
Biotechnology Materials		915	980	0	1047	1100
Biotechnology	674-23-08	915	980	0	1047	1100
Enhanced Hybridoma Production Using Electrofusion	674-23-08-11	200	300	0	780	
Separation of Intact Chromosome-size DNA	674-23-08-12	135	130	0	780	
Electrophoresis Technology	674-23-08-14	135	165	0	165	
Protein Crystal Nucleation Process	674-23-08-16	90	90	0	901	
Crystallographic Studies of Proteins	674-23-08-17	125	125	0	125	
Growth of DNA Crystals in a Micrograv. Envir.	674-23-08-18	100	10	0	780	
Protein Crystal Growth in Low Gravity	674-23-08-19	150	160	0	780	
Fluid Dynamics & Transport Phenomena		500	479	0	504	0
Fluid Dynamics and Transport Phenomena	674-24-08	500	479	0	504	0
Residual Acceleration Data on IML-1	674-24-08-05	170	204	0	204	
Cryogenics Equivalence Principle Experiment	674-24-08-07	175	275	0	300	
Roles of Fluid Motion	674-24-08-04	95	0	0		
Data Base Analysis in House	674-24-08-06	60	0	0		
Metals and Alloys		886	831	0	270	0
Metals and Alloys	674-25-08	886	831	0	270	0
Containerless High Temp. Property Measurements	674-25-08-16	115	120	0	120	
Influence of Convection of Microstructure	674-25-08-17	85	85	0	0	
Immiscible Phase Incorporation - Direct. Solidif.	674-25-08-18	90	10	0	0	
Containerless Processing	674-25-08-19	160	160	0	0	
Containerless Process of Refractory Metals	674-25-08-20	120	140	0	0	
Coarsening in Solid-Liquid Mixtures	674-25-08-21	166	166	0	0	
Containerless Processing of Oxide Supercond.	674-25-08-22	150	150	0	150	

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OFFICE OF SPACE SCIENCE & APPLICATIONS  
MARSHALL SPACE FLIGHT CENTER  
FY91 RESEARCH & TECHNOLOGY OBJECTIVES & PLANS  
SUMMARY REQUIREMENTS BY DIVISION (NOA, SK)

PROJECT -----	UPN ---	FY90 ---	FY91 GUIDELINE -----	FY91 OVER GUIDELINE -----	FY92 ---	FY93 ---
Microgravity Science and Applications Division (Continued)						
-----						
Glasses and Ceramics		85	0	0	0	0
Glasses and Ceramics	674-26-08	85	0	0	0	0
Investigation of Glass Formation	674-26-08-05	15	0	0	0	
Use of Microgravity to Improve Power Output	674-26-08-06	70	0	0	0	
Ground Experiment Operations		615	570	0	570	0
Ground Experiment Operations	674-28-08	615	570	0	570	0
Drop Tube Experiments	674-28-08-02	340	340	0	340	
Experiment Operations on KC-135 Aircraft	674-28-08-04	230	230	0	230	
Ground Experiment Operations IMS	674-28-08-01	45	0	0	0	
Consulting & Program Support		684	668	0	948	970
Consulting & Program Support	674-29-08	684	668	0	948	970
USRA Postdoctoral Support	674-29-08	260	298	0	500	
Consulting & Program Support IMS	674-29-08	413	371	0	418	
Ground Based Principal Investigator Status Support	674-29-08	0	0	0	30	
Program Dev. Support - IMS	674-29-08-07	11	0	0	0	

# COMMERCIAL PROGRAMS

- CONTENT:
  - SUPPORT TO CCDS's
  - ORGANIC POLYMER EXPER ACCOMMODATION FAC (FY 92)
  - DATA BASE DEVELOPMENT
  - SPACE STATION REQUIREMENTS
  - SYSTEMS ENGINEERING SUPPORT
  - CRYSTAL GROWTH INTEGRATION
  - PROCESS MODELING
  - PROCESS MODELING KC-135 FLIGHTS
  - MPS CONTAINER STUDY
  - COMMERCIAL PROJECTS TECHNOLOGY SUPPORT (NEW TASK)

	FUNDING		MANPOWER	
		CS	SC	TOTAL
-- FY 90	\$ 1,050 M	7.0	--	7.0
-- FY 91	1,673 (R)	5.0	--	5.0
-- FY 92	2,421 (R)	5.0	--	5.0
-- FY 93	2,565 (R)	5.0	--	5.0
-- FY 94	3,194 (R)	5.0	--	5.0
-- FY 95	3,699 (R)	5.0	--	5.0

- MANAGEMENT:
  - PROGRAM DEVELOPMENT
  - OFFICE OF COMMERCIAL PROGRAMS (R) = REQUESTED

MARSHALL SPACE FLIGHT CENTER  
COMMERCIAL USE OF SPACE (CUS)  
PROGRAM OPERATING PLAN 90-2  
NOA(\$K)

PROJECT TITLE/TASK	PR YRS	FY90	FY91	FY92	FY93	FY94	FY95	FY96	BIC	TOTALS
SUPPORT TO CCSS	34	30	50	50	52	54	56	58	0	384
PROTEIN CRYSTAL GROWTH UPGRADE III	1175	0	0	0	0	0	0	0	0	1175
MOLECULAR WAKE SHIELD FACILITY (SURF)	852	0	0	0	0	0	0	0	0	852
GROUP 2 BASED FURNACE	950	0	0	0	0	0	0	0	0	950
ORGANIC POLYMER EXPER ACCOM FAC (OPEAF)	300	100	0	436	100	100	100	100	0	1236
PROCESS MODELING	1085	25	165	150	150	175	175	175	0	1124
PROCESS MODELING - KC-135 FLIGHTS	0	100	50	25	0	0	0	0	0	175
MPS CONTAINER STUDY	0	50	100	100	0	0	0	0	0	250
ADVANCED PLANNING	617	0	0	0	0	0	0	0	0	617
DATA BASE	333	100	300	350	350	350	350	350	0	2483
SPACE STATION REQUIREMENTS	325	300	400	400	400	400	400	400	1200	4225
COST/ECONOMIC MODELING	300	0	0	0	0	0	0	0	0	300
SBIR SPT SVCS CONTRACT	110	0	0	0	0	0	0	0	0	110
PMS SUPPORT	1186	0	0	0	0	0	0	0	0	1186
INTEGRATION & FLIGHT SUPPORT	150	0	0	0	0	0	0	0	0	150
SYSTEM ENGINEERING SUPPORT	0	150	300	500	1000	1500	2000	1000	0	6450
CRYSTAL GROWTH INTEGRATION	0	150	150	150	150	150	150	150	0	1050
JEATEA-SBIR SUPPORT	495	45	58	60	63	65	68	70	0	478
TOTAL BASE PROGRAMS:	6490	1050	1573	2221	2265	2794	3299	2303	1200	23195

PROPOSED NEW TASKS:  
COMMERCIAL PROJECTS TECHNOLOGY SUPPORT

0	0	0	100	200	300	400	400	300	0	1700
6490	1050	1673	2421	2565	3194	3699	2603	1200	24835	

ORIGINAL PAGE IS  
OF POOR QUALITY

# SBIR

## • CONTENT:

### PHASE II

- INTERFACIAL & SURFACE TENSION
- HIGH Tc SUPER CONDUCTING MATERIAL
- CONVECTION STUDIES

### PHASE I

- FURNACE TECHNOLOGY
- MICRO-G SONIC PUMP LEVEL

## • RESOURCES:

	FUNDING	MANPOWER		
		CS	SC	TOTAL
-- FY 90	\$ 1.283 M	1.2	--	1.2
-- FY 91	1.591	1.2	--	1.2
-- FY 92				

## • MANAGEMENT RESPONSIBILITIES:

- S&E RESEARCH & TECHNOLOGY OFFICE

- OCP



# CDDF

- CONTENT:
  - KIRKENDALL EFFECT                      -- PHASE PARTITIONING
  - ROTARY CRYSTALLIZATION CHAMBER       -- HIGH Tc GLASS SYSTEMS
  - DNA ELECTROPHORESIS                   -- HIGH Tc MATERIALS
  - BIOCONVECTION

## ● RESOURCES:

	FUNDING	MANPOWER		
		CS	SC	TOTAL
-- FY 90	\$ 290 K	1.2	--	1.2
-- FY 91	211	1.2	--	
-- FY 92				

## ● MANAGEMENT RESPONSIBILITY:

- S&E
- NASA ASSOCIATE DEPUTY ADMINISTRATOR

Microgravity Science & Application Division's  
Historically Black College & University Grants

<u>Title</u>	<u>Grant No.</u>	<u>Award Date</u>	<u>College/Univ.</u>	<u>Funding</u>	<u>SSL Monitor</u>
Determination of Trace Metals in Triglycine Sulfate Solutions	NAG8-090	5/87	Alabama A&M	\$ 98K	Frazier
Study of Non Linear Properties of Organic Materials in Lead-Tin Fluorophosphate Glasses and Thin Films/Polymer Composites	NAG8-107	8/88	Alabama A&M	339K	Frazier
Experimental and Theoretical Studies of Bulk Phase Associations in succinonitrile-Water System	NAG8-088	5/87	Dolphus Milligan Science	163	Frazier
Theoretical and Experimental Studies of Non Linear Optical Properties of pi-Conjugated Polymers	NAG8-094	9/87	Dolphus Milligan Science	261K	Frazier
Ellipsometric Measurement of Liquid Film Thickness	NAS8-173	9/90	Alabama A&M	72K	Frazier
Growth and Characterization of Organic Crystals for Nonlinear Optical Applications	NAG8-125	4/89	Alabama A&M	108K	Frazier
Thermal Characteristics of Crystals	NAG8-(25	7/84	Fisk Univ.	770K	Kroes
Crystal Growth Characteristics of Ternary ZNXCDIX, SED, ZNX, CD, TE Single Crystals	NAG8-113	8/88	Fisk Univ.	151K	Kroes
			<u>TOTAL</u>	<u>\$1,962K*</u>	

Average FY 84-90 - \$280K/year

# MICROGRAVITY FUNDING SUMMARY

ELEMENT	FY 90	FY 91	FY 92	FY 93	FY 94
• PAYLOAD PROJECTS* (UPN 694 & 412)	\$ 33.222M	\$ 26.429M	\$ 25.853M	28.272M	\$ 25.787M
• SRT (UPN 674)	4.420	4.233	3.834	2.070	--
• COMMERCIAL (UPN 142)	1.050	1.843	2.421	2.565	3.194
• CDDE	0.290	.211	--	--	--
• SBIR	1.283	1.591	--	--	--
TOTAL	\$ 40.265M	\$ 34.107M			

\* CONTRACTORS ON OR NEAR SITE

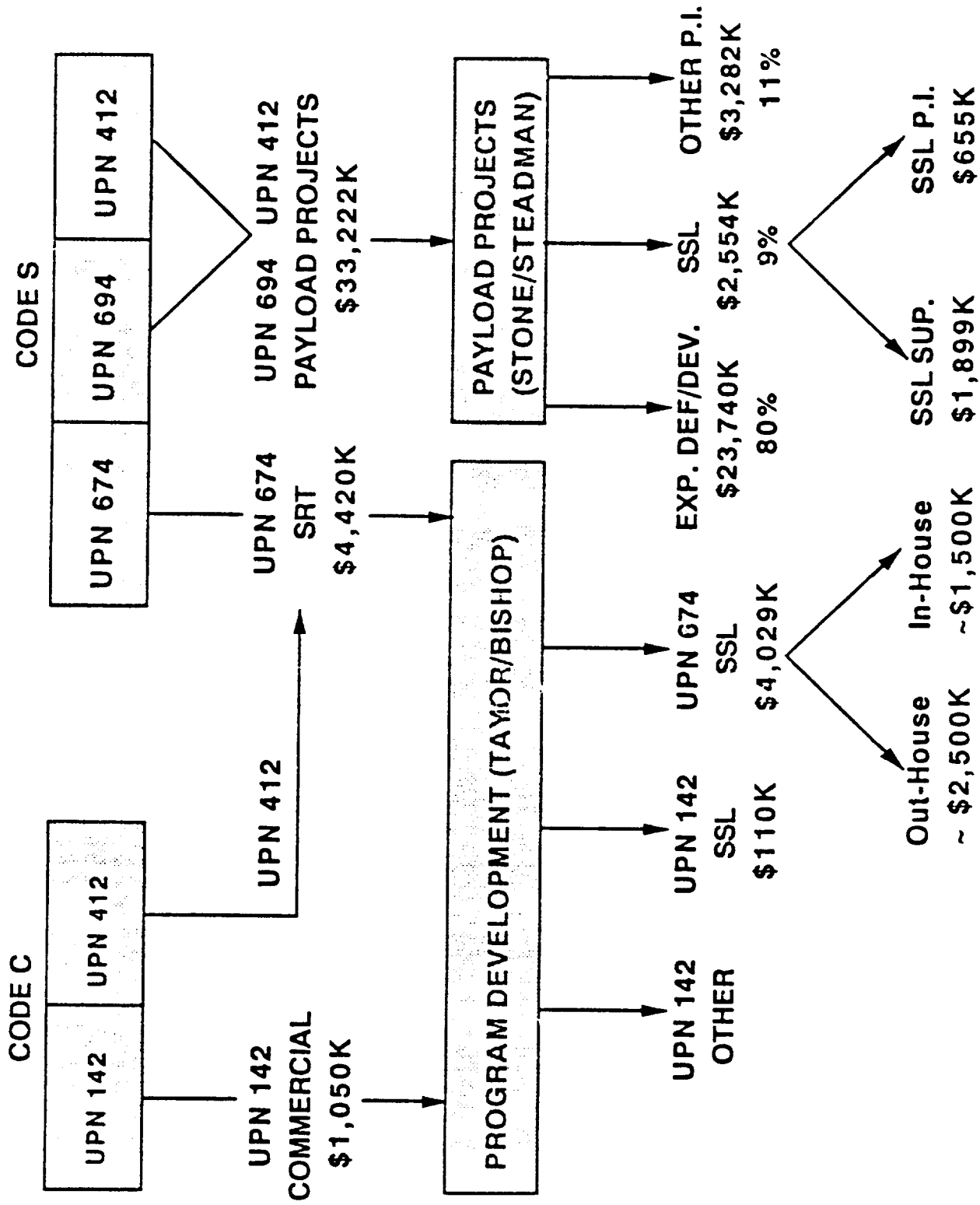
# MICROGRAVITY MANPOWER SUMMARY

ELEMENT	FY 90 (ACTUAL)		FY 91		FY 92	
	CS	SC*	CS	SC*	CS	SC*
● PAYLOAD PROJECTS	103.0	5.0	106.8	5.0	100.0	5.0
● SRT	12.8	6.0	19.5	9.0	20.9	9.0
● COMMERCIAL	6.7	--	5.0	--	5.0	--
● CDDF	1.2	--	1.2	--	--	--
● SBIR	**	--	**	--	**	--
TOTAL	123.7	11.0	132.5	14.0	125.9	14.0

\* INCLUDES UAH, STC AND SVERDRUP. EXCLUDES VISITING SCIENTISTS.  
 \*\* MANPOWER NOT ALLOCATED FOR SBIR

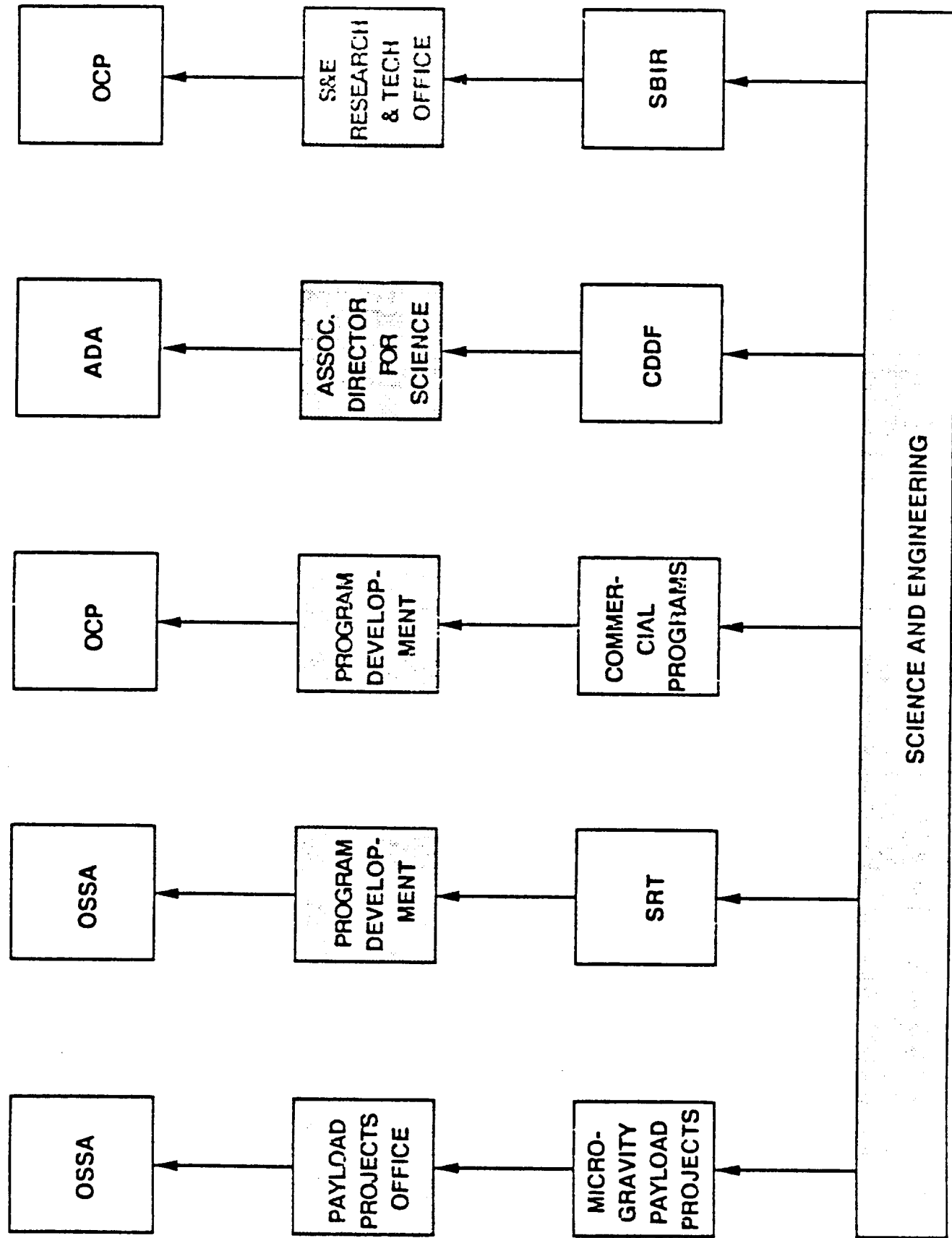
# MSFC MICROGRAVITY PROGRAM UPN FLOW

FY-90



NOTE: TOTAL SSL FY-90 MICROGRAVITY BUDGET - ~8M,  
INCLUDING ABOVE, PLUS 1283K SBIR, PLUS 290K CDDF

MSFC MICROGRAVITY PROGRAM ELEMENT MANAGEMENT RESPONSIBILITIES



PREVIOUS RESPONSIBILITIES

AND

POSSIBLE CONSIDERATIONS

MICROGRAVITY MATERIALS PROCESSING PROGRAM  
REFLECTIONS OF HISTORY/RESPONSIBILITIES WITHIN CENTER

---

ZOLLER ERA

- MSFC IS DOMINANT CENTER IN NASA'S MICROGRAVITY PROGRAM.
- DEDICATED PROGRAM OFFICE AT MSFC REPORTING TO CENTER DIRECTOR
- EMERGING COMMERCIAL OUT-REACH PROGRAM LED BY MSFC.
- ZOLLER'S OFFICE CONTROLLED ALL FUNDING AND ALL WORK, EVEN INCLUDING DIRECT TECHNICAL SUPERVISION OF ALL SCIENCE AND SRT CONTRACTS, PLUS DROP TUBE/DROP TOWER FACILITY, ETC.
- SCIENCE WORK IN SSL PERCEIVED TO BE DIFFUSE.



MICROGRAVITY MATERIALS PROCESSING PROGRAM  
REFLECTIONS OF HISTORY/RESPONSIBILITIES WITHIN CENTER  
(CONTINUED)

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BOB MARSHALL/NAUMANN/DOWNEY ERA

- COMMERCIAL PROGRAM ASSIGNED TO PROGRAM DEVELOPMENT - PARTICULARLY ACTIVE PRIOR TO CHALLENGER ACCIDENT.
- FLIGHT EXPERIMENTS AND EXPERIMENT FACILITIES DEVELOPMENT PROJECTS ASSIGNED TO PAYLOAD PROJECTS OFFICE - FES/VCGS, MEA AND MEA EXPERIMENTS, MLR, ADSE I & II, SAAL, FMS, IEF, MSL, AADSE, ET.AL.
- OSSA MICROGRAVITY SRT PROGRAM PLANNED AND IMPLEMENTED BY SSL UNDER PROGRAM DEVELOPMENT VIA OSSA RTOP SYSTEM.
- DROP TUBE/DROP TOWER FACILITY AND EXPERIMENTS ASSIGNED TO S&E/SSL.
- KC-135 EXPERIMENTS PLANNING ASSIGNED TO S&E/SSL.
- NO NEW MAJOR FLIGHT DEFINITION/DEVELOPMENT PROJECTS INITIATED AT MSFC UNDER OSSA SPONSORSHIP.
- SSL DIRECTOR (DESSLER) NOT ENTHUSIASTIC ABOUT PROJECT SCIENTIST'S ROLE.
- CENTER DIRECTOR (LUCAS) LOOKED TO PROGRAM DEVELOPMENT, I.E., BOB MARSHALL (WITH BOB NAUMAN INPUT) FOR PLANNING MSFC'S MICROGRAVITY PROGRAM AND AS THE FOCAL POINT FOR MSFC MICROGRAVITY ACTIVITIES.

MICROGRAVITY MATERIALS PROCESSING PROGRAM  
REFLECTIONS OF HISTORY/RESPONSIBILITIES WITHIN CENTER  
(CONTINUED)

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J.R. THOMPSON/JACK LEE/CRAFT ERA

- RESPONSIBILITIES FOR MICROGRAVITY PROGRAM ACTIVITIES REMAIN DIVIDED ALONG LINES ESTABLISHED IN PREVIOUS ERA.
- NEW MAJOR PROJECT DEFINITION EFFORTS INITIATED WITH LIMITED PARTICIPATION FROM PROGRAM DEVELOPMENT.
  - PROGRAM DEVELOPMENT, WITH REDUCED MANPOWER RESOURCES CONCENTRATING ON LAUNCH VEHICLE SYSTEMS AND, MORE RECENTLY, THE SPACE EXPLORATION INITIATIVE.
- SSL DIRECTOR (DR. TANDBERG-HANSEN) SUPPORTIVE OF PROJECT SCIENTIST'S ROLE.
- SCIENCE WORK IN SSL FOCUSED.
- SIGNIFICANT EMPHASIS IS BEING PLACED BY PAYLOAD PROJECTS OFFICE ON SPACE STATION PAYLOAD PLANNING ACTIVITIES.
- NASA CENTERS' RESPONSIBILITIES FOR THE COMMERCIAL PROGRAM DRASTICALLY REDUCED UNDER JIM ROSE. MAJOR COMMERCIAL PROJECT ASSIGNMENTS TO NASA CENTERS ARE UNLIKELY UNDER ROSE'S POLICIES.
- CENTER DIRECTOR (LEE) AND HIS PREDECESSOR, SEEM TO VIEW PAYLOAD PROJECTS OFFICE AS THE MSFC FOCAL POINT FOR MICROGRAVITY PROGRAM PLANNING AND IMPLEMENTATION.

AREAS OF SCIENTIFIC EMPHASIS

MICROGRAVITY DIVISION. SPACE SCIENCE LABORATORY

- CRYSTAL GROWTH OF ELECTRONIC AND PHOTONIC MATERIALS
- ORGANIC AND POLYMERIC MATERIALS, NON-LINEAR OPTICS
- PROTEIN CRYSTAL GROWTH, BIOLOGICAL SEPARATIONS

NOTE: IT HAS BEEN JUDGED THAT NINETY PER CENT OF SPACE SCIENCE LABORATORY'S CURRENT EFFORT IS FOCUSED IN THESE THREE AREAS. THERE APPEARS TO BE AN APPROPRIATE COMPLEMENT OF MUTUALLY SUPPORTIVE EXPERIMENTAL AND THEORETICAL WORK.

## SPACE STATION FREEDOM PROGRAM

### GENERAL COMMENTS

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- MICROGRAVITY AND LIFE SCIENCES ARE KEY DISCIPLINES FOR SPACE STATION.
- CONGRESS IS SUPPORTIVE OF THE MICROGRAVITY AREA BECAUSE OF POTENTIAL APPLICATIONS.
- THE SPACE STATION FREEDOM PROGRAM HAS BEEN BUFFETED BY MANY PRESSURES.
- THERE MUST BE A DETERMINED, SUSTAINED EFFORT BY THE MICROGRAVITY COMMUNITY TO INFLUENCE THE SSFP DESIGN TO ACCOMMODATE MICROGRAVITY REQUIREMENTS.

[illegible]

MICROGRAVITY INPUT TO SPACE STATION

- ESTABLISHED AND FUNCTIONING ORGANIZATIONAL LINES OF COMMUNICATION,
- PAYLOAD ORGANIZATIONS IN OSSA CODE SM (CRESSY) AND MSFC PAYLOAD PROJECTS OFFICE (WICKS) DEDICATED TO SPACE STATION.
- RE-ESTABLISHMENT OF CHIEF SCIENTIST POSITION AT MSFC IS TIMELY AND DESIRABLE.
- MSFC HAS EXPERIENCED MICROGRAVITY PEOPLE IN KEY POSITIONS IN SPACE STATION RIG STRUCTURE.
- OSSA HAS AN EFFECTIVE FRONT OFFICE PERSON ASSIGNED - ASST. ASSOC. ADM. FOR SPACE STATION.

ESTABLISH PAYLOAD PROJECTS OFFICE AS CENTER'S  
FOCAL POINT FOR OSSA'S MICROGRAVITY PROGRAM

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SUPPORTING CONSIDERATIONS

- OSSA'S SRT RTOP'S ARE BY DEFINITION FOCUSED TECHNOLOGY, IN CONTRAST TO OAET'S SRT PROGRAM. THERE SHOULD BE A STRONG COUPLING BETWEEN THE MICROGRAVITY SRT/ADVANCED TECHNICAL DEVELOPMENT PROGRAM AND FUTURE FLIGHT PROJECTS DEFINITION AND DEVELOPMENT WORK IN PAYLOAD PROJECTS OFFICE. PROCEEDING WITH DEVELOPMENT OF MICROGRAVITY FLIGHT PROJECTS WITHOUT A PROPER TECHNOLOGICAL FOUNDATION IS BELIEVED TO HAVE CONTRIBUTED SIGNIFICANTLY TO DEVELOPMENT PROBLEMS.
- THERE HAVE BEEN INDICATIONS THAT THE MSFC CENTER DIRECTOR IS CONFUSED (UNDERSTANDABLY) ABOUT WHICH OF HIS ORGANIZATIONS IS RESPONSIBLE FOR WHICH PARTS OF THE MICROGRAVITY PROGRAM.
- PROGRAM DEVELOPMENT ADDS LITTLE VALUE TO THE MANAGEMENT OF OSSA'S MICROGRAVITY SRT PROGRAM.
- IT IS CONVENIENT TO HAVE A SINGLE ORGANIZATION RESPONSIBLE FOR PROGRAMMATIC AND MANAGEMENT OVERSIGHT OF A PROGRAM ACTIVITY.

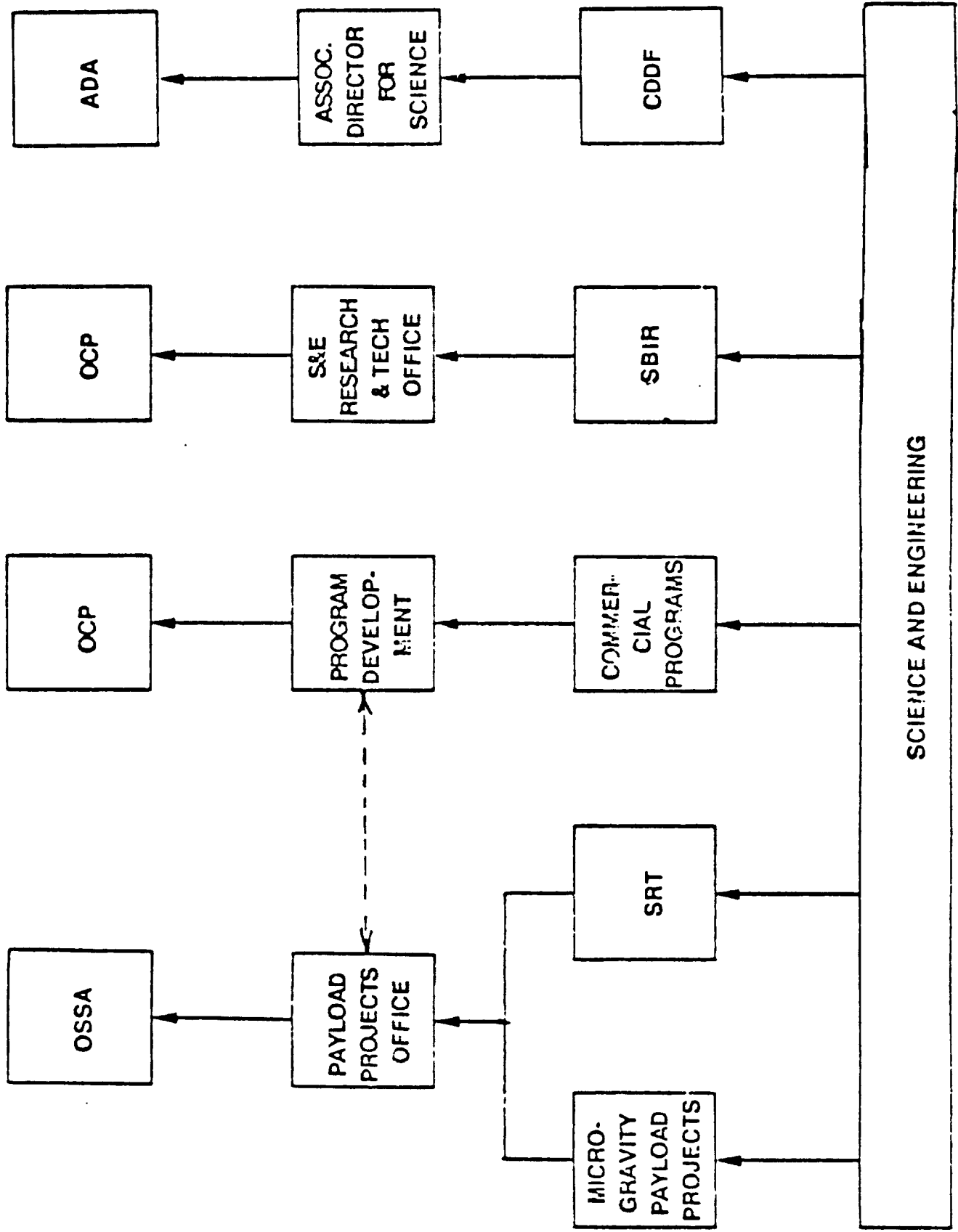
DISADVANTAGES

- PUTTING PAYLOAD PROJECTS OFFICE IN CHARGE OF OSSA'S MICROGRAVITY SRT PROGRAM COULD BE VIEWED AS LIMITING SCIENTIFIC INITIATIVE AND FREEDOM IN THE SRT PROGRAM.

CHALLENGE

- APPROPRIATELY COUPLE THE PLANNING OF SRT/ATD ACTIVITY TO FUTURE FLIGHT PROJECT GOALS, AND AT THE SAME TIME NOT STIFLE CREATIVITY OR INNOVATION IN SRT EFFORTS.

NSFC MICROGRAVITY PROGRAM ELEMENT MANAGEMENT RESPONSIBILITIES





## OBSERVATIONS

- OSSA SEEMS TO BE MOVING TOWARD A SCIENCE COMMUNITY DRIVEN MICROGRAVITY PROGRAM.
- MICROGRAVITY SCIENCE ACTIVITIES IN SSL APPEAR TO BE WELL FOCUSED INTO APPROPRIATELY CHOSEN AREAS OF RESEARCH.
- SSL IS USING AVAILABLE FUNDING AND MANPOWER RESOURCES EFFECTIVELY TO SUPPORT SELECTED RESEARCH INTERESTS.
- ASSIGNED SRT WORK TO MSFC BY OSSA INVOLVING RESEARCH AT VARIOUS UNIVERSITIES AND INSTITUTIONS IS COMPLEMENTARY TO MSFC RESEARCH INTERESTS.
- ADDITIONAL FUNDING SHOULD BE SOLICITED FROM CODE SN FOR ADDITIONAL ADVANCED TECHNICAL DEVELOPMENT WORK.
- EXPERIMENT SCIENTIST/PROJECT SCIENTIST ROLE AT MSFC HAS BEEN STRENGTHENED, E.G., DR. SZOFRAN ON CGF.
- PAYLOAD PLANNING FOR SPACE STATION NOW BEING ACTIVELY SUPPORTED AT MSFC, E.G., WICKS, CHASSAY, FOUNTAIN.
- LEN FISK IS TAKING A CONSERVATIVE POSTURE RELATIVE TO DEVELOPMENT OF SPACE STATION PAYLOADS.
- COMMERCIAL PROGRAM IS REPORTED TO HAVE AGREED TO PROVIDE 50% OF U.S. PAYLOAD COMPLEMENT FOR SPACE STATION.
- MICROGRAVITY ACTIVITIES AT MSFC REMAIN DECENTRALIZED.

## GOALS & OBJECTIVES

## GOALS

### NASA MICROGRAVITY SCIENCE AND APPLICATIONS DIVISION

- "DEVELOP A COMPREHENSIVE RESEARCH PROGRAM IN FUNDAMENTAL SCIENCES, MATERIALS SCIENCE AND BIOTECHNOLOGY FOR THE PURPOSE OF ATTAINING A STRUCTURED UNDERSTANDING OF GRAVITY DEPENDENT PHYSICAL PHENOMENA IN BOTH EARTH AND NON-EARTH ENVIRONMENTS."
- "FOSTER THE GROWTH OF AN INTERDISCIPLINARY RESEARCH COMMUNITY, UNITED BY SHARED GOALS AND RESOURCES, TO CONDUCT RESEARCH IN THE SPACE ENVIRONMENT."
- "ENCOURAGE INTERNATIONAL COOPERATION FOR THE PURPOSE OF CONDUCTING RESEARCH IN THE SPACE ENVIRONMENT."
- "UTILIZE A PERMANENTLY MANNED, MULTI-FACILITY NATIONAL MICROGRAVITY LABORATORY IN LOW-EARTH ORBIT TO PROVIDE A LONG-DURATION, STABLE MICROGRAVITY ENVIRONMENT."
- "PROMOTE INDUSTRIAL APPLICATIONS OF SPACE RESEARCH FOR THE DEVELOPMENT OF NEW, COMMERCIALY VIABLE PRODUCTS, SERVICES, AND MARKETS RESULTING FROM RESEARCH IN THE SPACE ENVIRONMENT."

## GOALS

### MSFC MICROGRAVITY PROGRAM

- DEVELOP A COMPREHENSIVE RESEARCH PROGRAM IN FUNDAMENTAL SCIENCES, MATERIALS SCIENCE AND BIOTECHNOLOGY FOR THE PURPOSE OF ATTAINING A STRUCTURED UNDERSTANDING OF GRAVITY DEPENDENT PHYSICAL PHENOMENA IN BOTH EARTH AND NON-EARTH ENVIRONMENTS WITH EMPHASIS IN THE FOLLOWING AREAS:
  - ELECTRONIC AND PHOTONIC MATERIALS CRYSTAL GROWTH
  - ORGANIC AND POLYMERIC MATERIALS
  - PROTEIN CRYSTAL GROWTH AND BIOLOGICAL SEPARATIONS
- ESTABLISH MSFC AS THE MICROGRAVITY DISCIPLINE DATA CENTER FOR NASA.
- EXPLOIT THE FULL CAPABILITIES OF THE SPACE SHUTTLE AND SPACELAB IN ACCOMPLISHING USEFUL SCIENCE IN THE SPACE ENVIRONMENT.
- PLAY A LEADING ROLE IN DEFINING THE MICROGRAVITY REQUIREMENTS FOR SPACE STATION FREEDOM THAT WILL ENABLE IT TO BE AN EFFECTIVE LONG-TERM FACILITY FOR CONDUCTING MICROGRAVITY SCIENCE AND APPLICATIONS.
- ESTABLISH MSFC AS MICROGRAVITY DISCIPLINE OPERATIONS CENTER SUPPORTING SPACE STATION OPERATIONS.
- THROUGH A PROGRAM OF SPACE RESEARCH AND DEVELOPMENT, FACILITATE THE DEVELOPMENT OF NEW, COMMERCIALY VIABLE PRODUCTS AND PROCESSES.

MSFC MICROGRAVITY PROGRAM  
PRIORITIES

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- CONTINUE TO IMPROVE COMMUNICATIONS AND WORKING RELATIONSHIPS
- ACCOMPLISH CURRENTLY ASSIGNED PROGRAM
- INVIGORATE GROUND BASED PROGRAM; REESTABLISH ADVANCED TECHNICAL DEVELOPMENT AREA
- MAKE DILIGENT EFFORT TO INFLUENCE SPACE STATION PAYLOAD ACCOMMODATIONS
- PURSUE ADDITIONAL PRINCIPAL INVESTIGATOR OPPORTUNITIES FOR MSFC SCIENTISTS
- CONTINUE AND EXPAND MICROGRAVITY DATA BASE (K.TAYLOR)
- CONTINUE SUPPORT OF COMMERCIAL PROGRAM, WHICH IS OF GREATLY INCREASED SIGNIFICANCE TO MSFC SPACE STATION PAYLOAD UTILIZATION/INTEGRATION ACTIVITY
- POSTURE MSFC TO BECOME THE MICROGRAVITY DISCIPLINE OPERATIONS CENTER FOR SPACE STATION

BACKGROUND

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- NASA'S MICROGRAVITY PROGRAM HAS INCREASED DRAMATICALLY IN THE DECADE OF THE 1980'S.
- MICROGRAVITY FUNDING FOR MSFC HAS GROWN CORRESPONDINGLY.
- MICROGRAVITY MATERIALS PROCESSING PAYLOADS ARE OF PRIMARY SIGNIFICANCE TO SPACE STATION FREEDOM.
- THE COMMERCIAL PROGRAM HAS EMERGED AS A SEPARATE PROGRAM WITH SIGNIFICANT EMPHASIS ON MICROGRAVITY WORK. CURRENT OCP POLICIES LIMIT INVOLVEMENT BY NASA CENTERS.
- A REASSESSMENT OF MSFC'S APPROACH TO THE MANAGEMENT OF THE COMPLEX AND DIVERSIFIED MICROGRAVITY PROGRAM ACTIVITIES MAY BE WARRANTED AT THIS TIME.

## NASA MICROGRAVITY PROGRAM

### PARTICIPANTS

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#### NASA PROGRAM OFFICE: OFFICE OF SPACE SCIENCE & APPLICATIONS

##### PARTICIPATING CENTERS

- MSFC

##### AREAS OF EMPHASIS

- ELECTRONIC AND PHOTONIC MATERIALS
- PROTEIN CRYSTAL GROWTH
- ORGANIC AND POLYMERIC MATERIALS

- LeRC

- COMBUSTION SCIENCE

- FLUID PHYSICS

- JPL

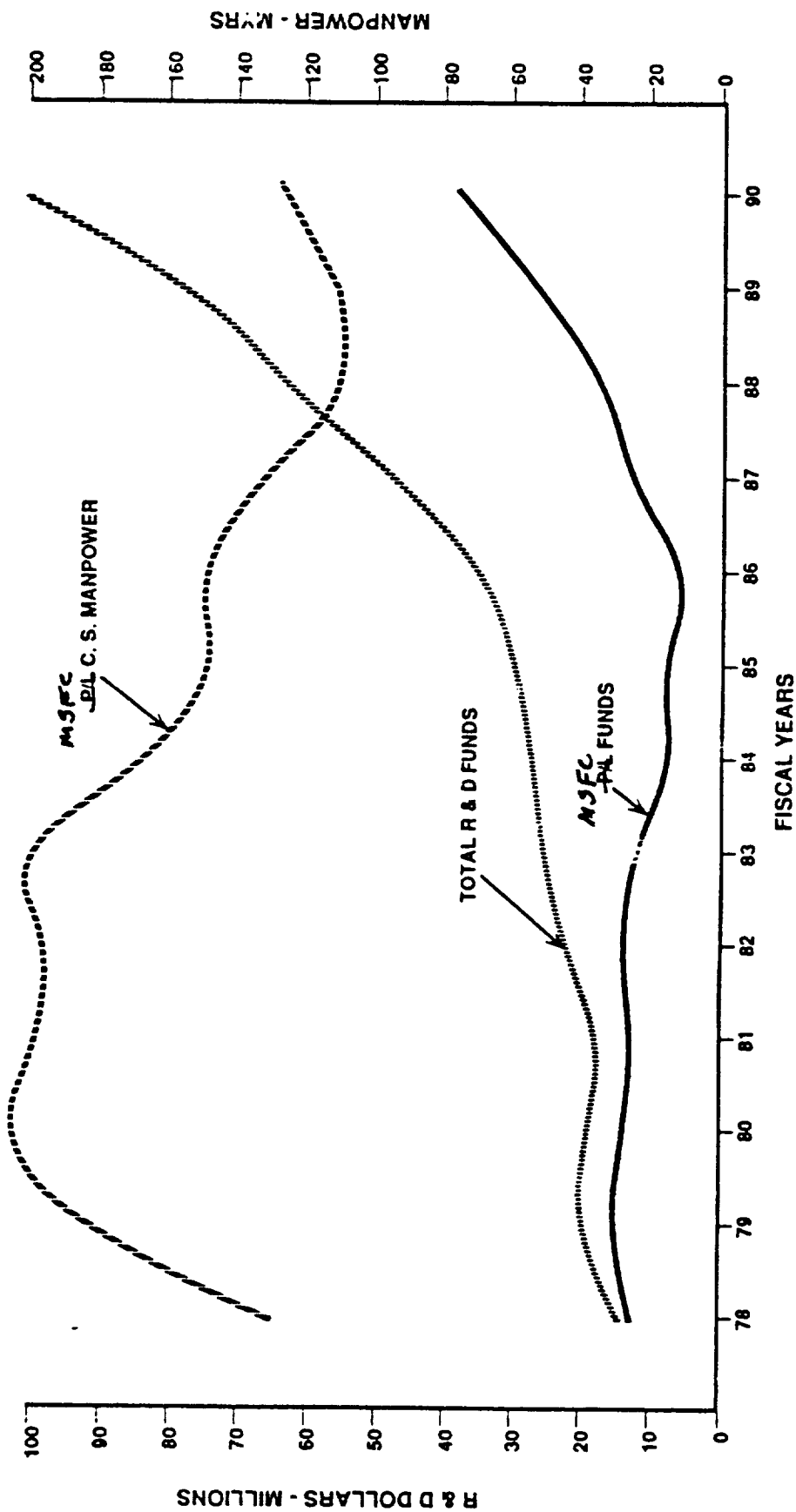
- DROP DYNAMICS

- CONTAINERLESS PROCESSING

- OTHERS

COMMENT - CENTER ROLES AND ACTIVITIES APPEAR REASONABLE WITH NO MAJOR AREAS OF UNDESIRABLE OVERLAP OR DUPLICATION.

055A  
TOTAL MICROGRAVITY R & D DOLLARS  
R & D DOLLARS TO MSFC  
MSFC C. S. MANPOWER  
(NOT INCLUDING COMMERCIAL PROGRAM)





MICROGRAVITY MATERIALS PROCESSING PROGRAM  
HISTORY/CENTER RESPONSIBILITIES

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ZOLLER ERA (≤ 1982)

- MSFC DOMINANT CENTER IN NASA'S MICROGRAVITY PROGRAM.
- DEDICATED PROGRAM OFFICE AT MSFC REPORTING TO CENTER DIRECTOR
- EMERGING COMMERCIAL OUT-REACH PROGRAM LED BY MSFC.
- ZOLLER'S OFFICE CONTROLLED ALL FUNDING AND ALL WORK, EVEN INCLUDING DIRECT TECHNICAL SUPERVISION OF ALL SCIENCE AND SRT CONTRACTS, PLUS DROP TUBE/DROP TOWER FACILITY, ETC.
- ANNUAL FUNDING LEVEL APPROXIMATELY 20M.

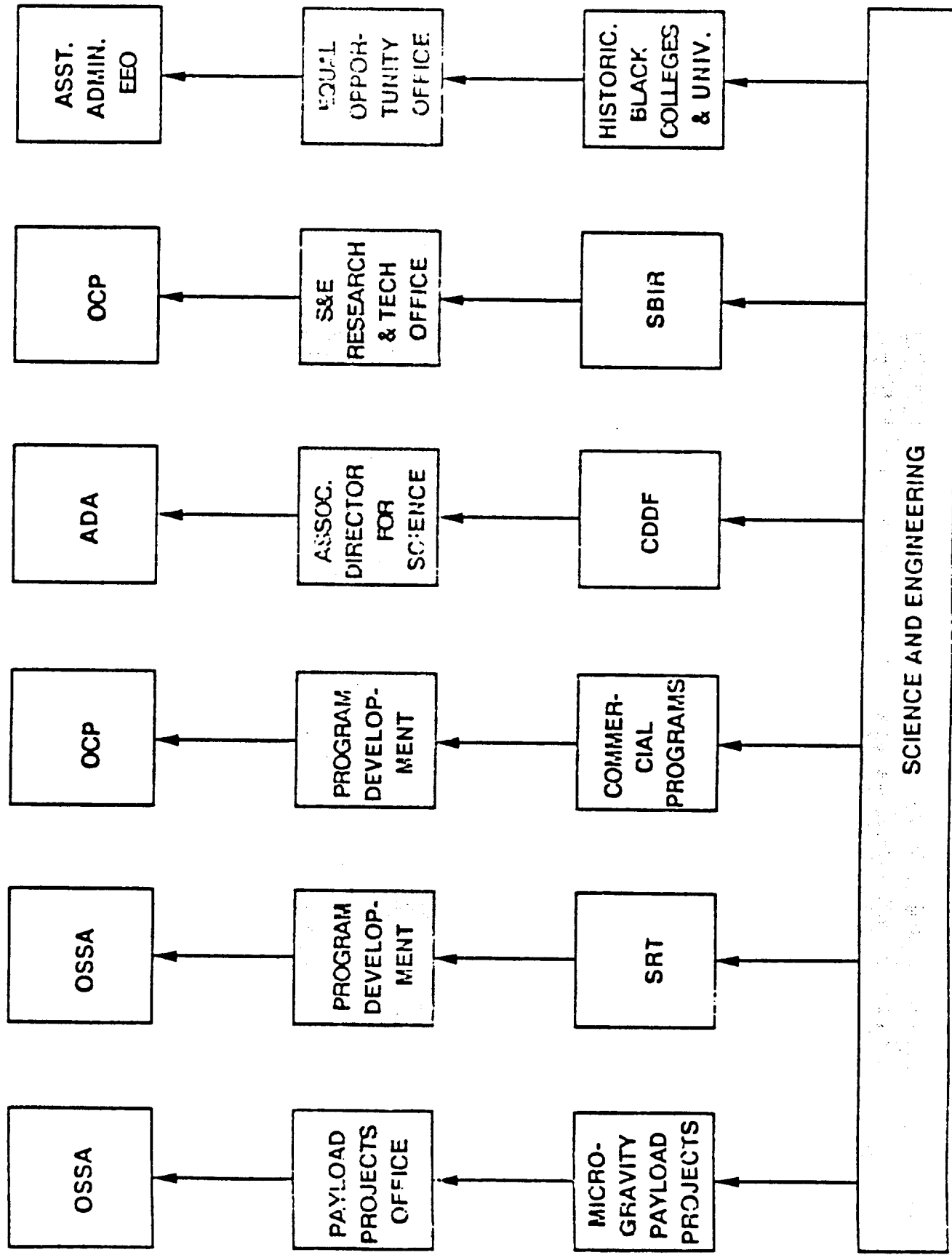
MICROGRAVITY MATERIALS PROCESSING PROGRAM  
CENTER RESPONSIBILITIES

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CURRENT ERA

- MSFC REMAINS A LEADING CENTER IN MICROGRAVITY FOR OSSA, BUT SIGNIFICANT PROGRAMS ALSO EXIST AT JPL AND LERC. TOTAL OSSA PROGRAM EXCEEDS 100M PER YEAR.
- MICROGRAVITY PROJECT AREAS AT MSFC MANAGED BY SIX DIFFERENT MSFC OFFICES.
  - OSSA FLIGHT EXPERIMENTS PROGRAM MANAGED BY PAYLOAD PROJECTS OFFICE.
  - OSSA SRT PROGRAM MANAGED BY SSL WITH PROGRAMMATIC OVERSIGHT BY PROGRAM DEVELOPMENT.
  - COMMERCIAL PROGRAM ACTIVITIES ARE MANAGED BY PROGRAM DEVELOPMENT. IMPLEMENTATION OF COMMERCIAL PROGRAM IS PRIMARILY THROUGH THE CENTERS FOR COMMERCIAL DEVELOPMENT OF SPACE.
  - SIGNIFICANT MICROGRAVITY EFFORT IN THE FOLLOWING PROGRAMMATIC AREAS:
    - CENTER DIRECTOR'S DISCRETIONARY FUND
    - SMALL BUSINESS INNOVATIVE RESEARCH PROGRAM
    - HISTORICALLY BLACK COLLEGES AND UNIVERSITIES

MSFC MICROGRAVITY PROGRAM ELEMENT MANAGEMENT RESPONSIBILITIES



# MICROGRAVITY FUNDING SUMMARY

ELEMENT	FY 90	FY 91	FY 92	FY 93
• PAYLOAD PROJECTS (UPN 694 & 412)	\$ 33.222M	\$ 27.518M	\$ 32.149M	\$ 41.198M
• SRT (UPN 674)	4.420	4.233	3.834	2.070
• COMMERCIAL (UPN 142)	1.050	1.070	2.421	2.565
• CDDE	0.290	.211	TBD	TBD
• SBIR	1.283	1.591	TBD	TBD
• HBCU	0.215	TBD	TBD	TBD
TOTAL	\$ 40.480M	\$ 34.623M	\$ 38.404M	\$ 45.833M

# MICROGRAVITY MANPOWER SUMMARY

ELEMENT	FY 90 (ACTUAL)		FY 91		FY 92	
	CS	SC*	CS	SC*	CS	SC*
• PAYLOAD PROJECTS	103.0	5.0	106.8	5.0	100.0	5.0
• SRT	12.8	6.0	19.5	9.0	20.9	9.0
• COMMERCIAL	6.7	--	5.0	--	5.0	--
• CDDE	1.2	--	1.2	--	--	--
• SBIR	**	--	**	--	**	--
• HECU	--	--	--	--	--	--
TOTAL	123.7	11.0	132.5	14.0	125.9	14.0

\* INCLUDES UAH, STC AND SVERDRUP. EXCLUDES VISITING SCIENTISTS.

\*\* MANPOWER NOT ALLOCATED FOR SBIR

# PAYLOAD PROJECTS

## ● SCOPE:

- FLIGHT EXPERIMENTS
- PRINCIPAL INVESTIGATOR SUPPORT
- MISSION SUPPORT
- FLIGHT HARDWARE DEFINITION & DEVELOPMENT

## ● RESOURCES:

	FUNDING		MANPOWER	
		(NOA GUIDELINES)	CS	SC* TOTAL
-- FY 90 (actual)	\$ 33,222		103.0	5.0 108.0
-- FY 91	27,518		106.8	5.0 111.8
-- FY 92	32,149		100.0	5.0 105.0
-- FY 93	41,198		100.0	5.0 100.0

## ● MANAGEMENT RESPONSIBILITY:

- PAYLOAD PROJECTS OFFICE
- OSSA

\* INCLUDES UAH, STC AND SVERDRUP. EXCLUDES VISITING SCIENTISTS.

## SUPPORTING RESEARCH & TECHNOLOGY

● **CONTENT:**

- ELECTRONIC MATERIALS  
-- BIOTECHNOLOGY MATERIALS  
-- FLUID DYNAMICS AND TRANSPORT PHENOMENA  
-- METALS AND ALLOYS  
-- GLASSES AND CERAMICS  
-- GROUND EXPERIMENT INTEGRATION  
-- CONSULTING AND PROGRAM SUPPORT

● **RESOURCES:**

FUNDING		MANPOWER		
		CS	SC*	TOTAL
--	FY 90 (actual)	\$ 4,420 M		
--	FY 91	4,233 (R)	12.8	6.0
--	FY 92	3,834 (R)	19.5	9.0
--	FY 93	2,070 (R)	20.9	9.0
			20.9	9.0
				18.8
				28.5
				29.9
				29.9

● **MANAGEMENT RESPONSIBILITY:**

- PROGRAM DEVELOPMENT
- OSA

**(R) = REQUESTED**

\* INCLUDES UAH, STC AND SVERDRUP. EXCLUDES VISITING SCIENTISTS

# COMMERCIAL PROGRAMS

## • CONTENT:

- SUPPORT TO CCDS's
- ORGANIC POLYMER EXPR ACCOMMODATION FAC (FY 92)
- DATA BASE DEVELOPMENT
- SPACE STATION REQUIREMENTS
- SYSTEMS ENGINEERING SUPPORT
- CRYSTAL GROWTH INTEGRATION
- PROCESS MODELING
- PROCESS MODELING KC-135 FLIGHTS
- MPS CONTAINER STUDY
- COMMERCIAL PROJECTS TECHNOLOGY SUPPORT (NEW TASK)

## • RESOURCES:

	FUNDING	MANPOWER		
		CS	SC	TOTAL
-- FY 90	\$ 1,050 M	7.0	--	7.0
-- FY 91	1,070 M	5.0	--	5.0
-- FY 92	2,421 (R)	5.0	--	5.0
-- FY 93	2,565 (R)	5.0	--	5.0

## • MANAGEMENT RESPONSIBILITY:

- PROGRAM DEVELOPMENT
- OFFICE OF COMMERCIAL PROGRAMS (R) = REQUESTED



# CDDF

## ● CONTENT:

- KIRKENDALL EFFECT
- ROTARY CRYSTALLIZATION CHAMBER
- DNA ELECTROPHORESIS
- BIOCONVECTION
- PHASE PARTITIONING
- HIGH Tc GLASS SYSTEMS
- HIGH Tc MATERIALS

## ● RESOURCES:

	FUNDING	MANPOWER		
		CS	SC	TOTAL
-- FY 90	\$ 290 K	1.2	--	1.2
-- FY 91	211	1.2	--	1.2
-- FY 92	TBD			
-- FY 93	TBD			

## ● MANAGEMENT RESPONSIBILITY:

- S&E
- NASA ASSOCIATE DEPUTY ADMINISTRATOR

# SBIR

- CONTENT:
  - PHASE II
    - INTERFACIAL & SURFACE TENSION
    - HIGH Tc SUPER CONDUCTING MATERIAL
    - CONVECTION STUDIES
  - PHASE I
    - FURNACE TECHNOLOGY
    - MICRO-G SONIC PUMP LEVEL

## ● RESOURCES:

	FUNDING		MANPOWER	
			CS	SC
				TOTAL
-- FY 90	\$ 1.283 M		1.2	1.2
-- FY 91	1.591		1.2	1.2
-- FY 92				

- MANAGEMENT RESPONSIBILITY:
  - S&E RESEARCH & TECHNOLOGY OFFICE
  - OCP

# HISTORICALLY BLACK COLLEGES & UNIVERSITIES (HBCU)

## • SCOPE:

- EXPERIMENTAL AND THEORETICAL STUDIES
- BASIC MATERIALS STUDIES
- CHARACTERIZATION OF MATERIALS, MEASUREMENT TECHNIQUES
- ORGANIC CRYSTAL GROWTH
- POLYMERIC MATERIALS
- ETC.

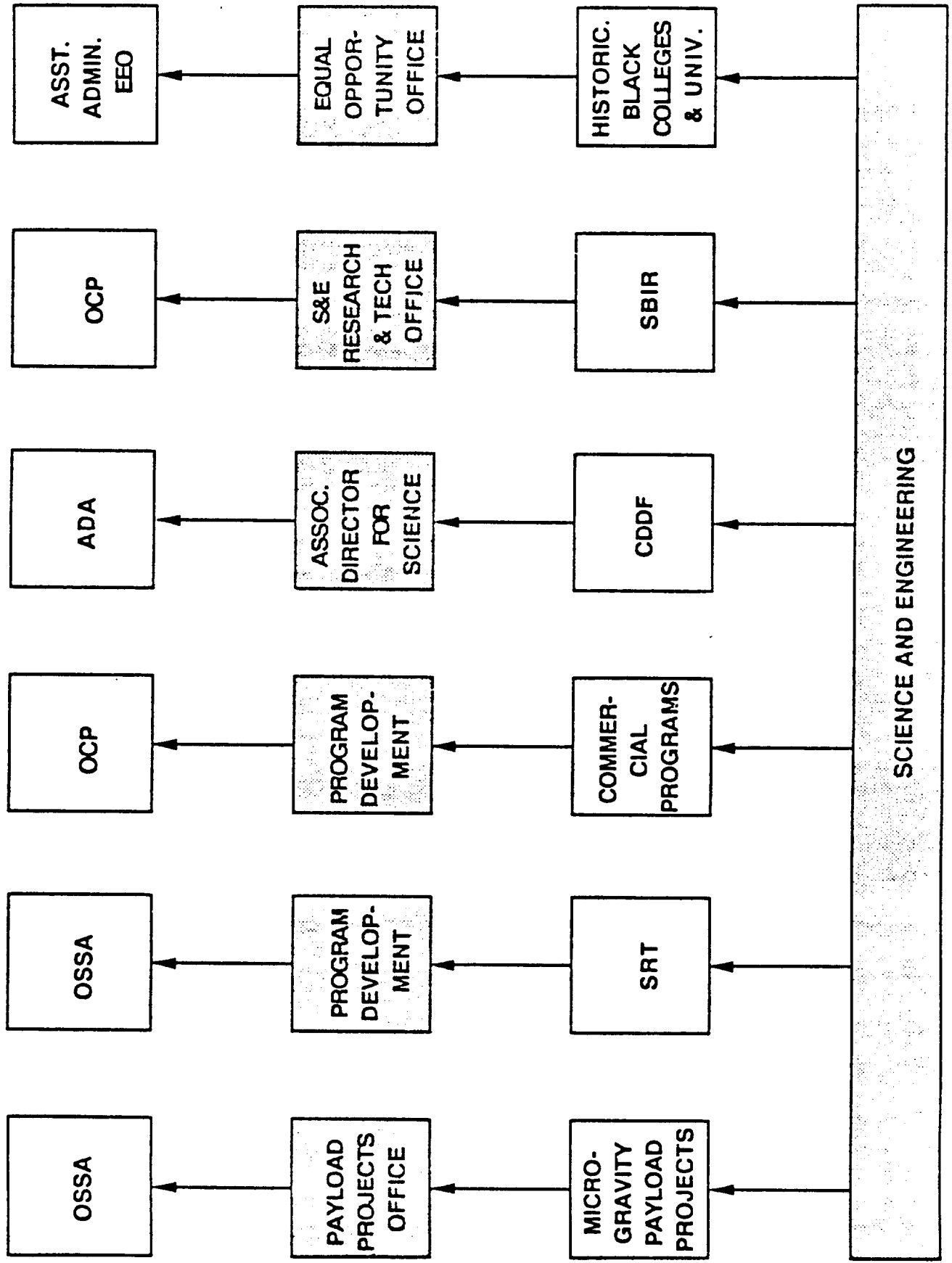
## • RESOURCES:

	FUNDING		MANPOWER	
	(NOA)	CS	SC	TOTAL
-- FY 90 (actual)	215K			
-- FY 91	TBD	NO	M/P	ALLOCATIONS

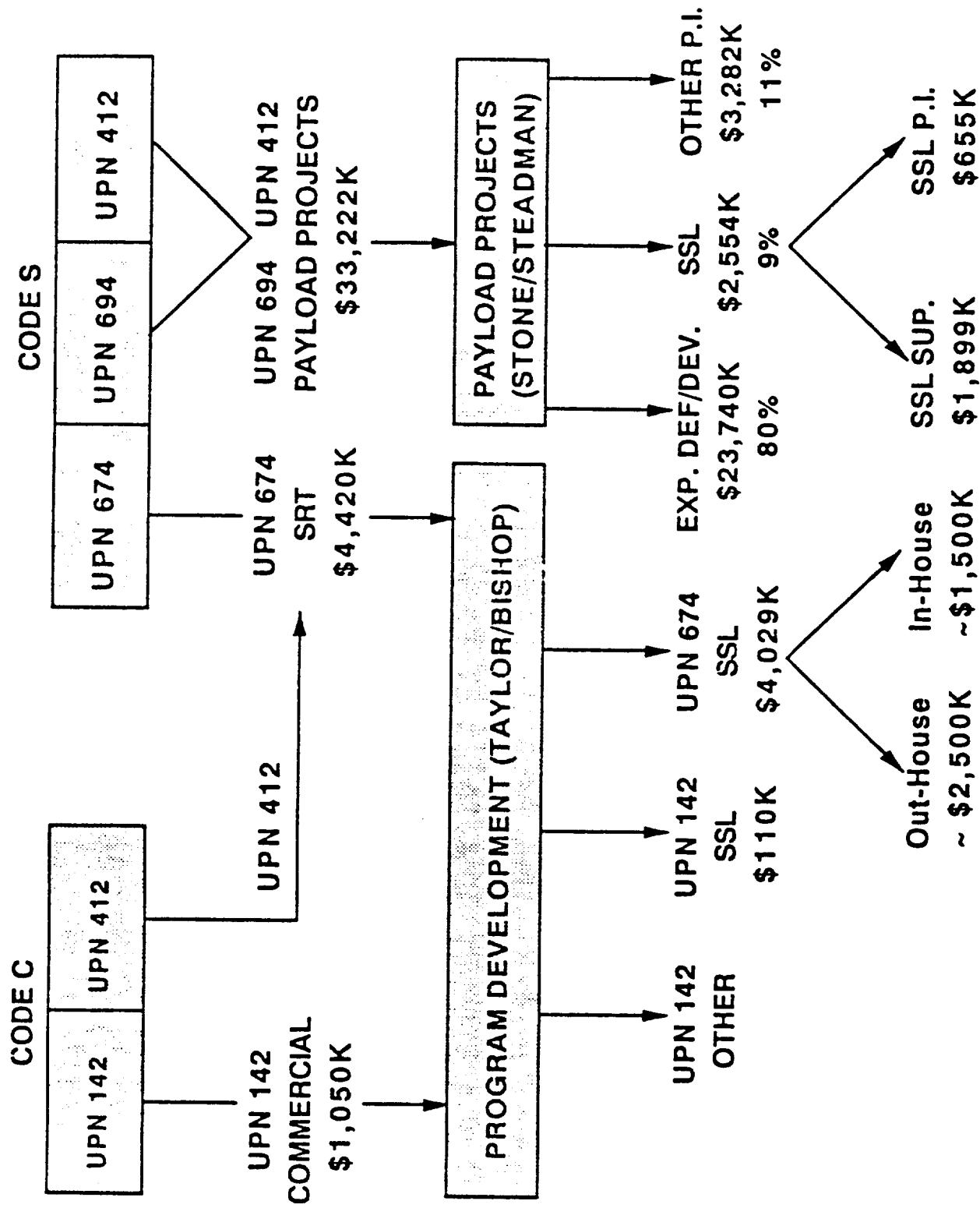
## • MANAGEMENT RESPONSIBILITY:

- EKO OFFICE
- S&E - SSL (SCIENCE OVERSIGHT)
- ASSISTANT ADMINISTRATOR EKO, HQ

MSFC MICROGRAVITY PROGRAM ELEMENT MANAGEMENT RESPONSIBILITIES



# MSFC MICROGRAVITY PROGRAM UPN FLOW FY-90



NOTE: TOTAL SSL FY-90 MICROGRAVITY BUDGET - ~8M,  
INCLUDING ABOVE, PLUS 1283K SBIR, PLUS 290K CDDF

## SUPPORTING RESEARCH AND TECHNOLOGY

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- THE OSSA MICROGRAVITY SRT AREA (UPN 674) IS RESERVED FOR PEER REVIEWED RESEARCH PROPOSALS AND IS ADMINISTERED VIA THE RTOP SYSTEM.
- THE SRT PROGRAM SUPPORTS MICROGRAVITY RESEARCH OF A BASIC AND FUNDAMENTAL NATURE.
- THE PEER REVIEWED RESEARCH PROPOSALS UNDER THE SRT PROGRAM HAVE RECEIVED CONTINUED FUNDING BY OSSA.
- THIS SRT PROGRAM AT MSFC IS IMPLEMENTED BY SSL; IT IS ADMINISTERED BY PROGRAM DEVELOPMENT.

## ADVANCED TECHNICAL DEVELOPMENT

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- THIS FOCUSED TECHNOLOGY PROGRAM IS VITAL TO SUPPORT THE DEVELOPMENT OF FUTURE FLIGHT APPARATUS AND EXPERIMENTS.
- THE OSSA MICROGRAVITY ADVANCED TECHNICAL DEVELOPMENT PROGRAM HAS BECOME ESSENTIALLY NON-EXISTENT BECAUSE OF FUNDING LIMITATIONS.
- OSSA AND FIELD CENTERS AGREE THAT THE ADVANCED DEVELOPMENT AREA SHOULD BE REVITALIZED AND FUTURE FUNDING "FENCED" SO IT WILL NOT BE WITHDRAWN FOR OTHER PURPOSES.
- THE ADVANCED TECHNICAL DEVELOPMENT WORK COUPLES WITH AND LEADS TO THE DEFINITION/DEVELOPMENT OF FLIGHT EXPERIMENTS AND PROJECTS. IT SHOULD BE MANAGED BY PAYLOAD PROJECTS OFFICE. WHEN THE ATD PROGRAM IS REESTABLISHED, IT WILL BE ADMINISTERED VIA THE POP PROCESS.

OBSERVATIONS/RECOMMENDATIONS

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- MSFC MICROGRAVITY WORK IS DIVERSIFIED IN SEVERAL PROJECT/ACTIVITY AREAS.
- CONSIDERATION SHOULD BE GIVEN TO IDENTIFYING AN OFFICE TO PROVIDE GENERAL MANAGEMENT AND PROGRAMMATIC OVERSIGHT OF MSFC MICROGRAVITY ACTIVITIES.
- FOCUS FOR CENTER MANAGEMENT, GENERAL MANPOWER AND FUNDING RESOURCES BEING UTILIZED FOR MICROGRAVITY WORK BY THE RESPONSIBLE MSFC OFFICES/ACTIVITIES.
- INFLUENCE CONTENT OF VARIOUS MSFC MICROGRAVITY ACTIVITIES AS APPROPRIATE TO ASSURE CONSISTENCY WITH CENTER OBJECTIVES.



## IMPLEMENTATION

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- EFFECT NO CHANGE IN CURRENT CENTER RESPONSIBILITIES, EXCEPT TO IDENTIFY EITHER PAYLOAD PROJECTS OFFICE OR PROGRAM DEVELOPMENT TO PROVIDE A FOCAL POINT FOR CENTER DIRECTOR FOR GENERAL INFORMATION AND PROGRAMMATIC OVERSIGHT OF MICROGRAVITY WORK AT MSFC.
- CONDUCT PERIODIC REVIEWS OF ALL CENTER MICROGRAVITY WORK
  - TO EXCHANGE INFORMATION AMONG PARTICIPANTS
  - TO IDENTIFY ANY CONCERNS OR PROBLEMS
  - TO IDENTIFY POSSIBLE WORK AREAS WHICH WARRANT MORE EMPHASIS
- PAYLOAD PROJECTS OFFICE, PROGRAM DEVELOPMENT, DIRECTOR OF S&E, AND OTHERS AS APPROPRIATE SHOULD PARTICIPATE WITH ASSOCIATE DIRECTOR OF SCIENCE IN CENTER REVIEWS OF MICROGRAVITY RESEARCH AND CDDF, SBIR AND KEO MICROGRAVITY PROPOSALS.

OFFICE OF COMMERCIAL PROGRAMS

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CHANGES IN POLICY BY THE OFFICE OF COMMERCIAL PROGRAMS INDICATE THAT MSFC'S ROLE MAY WARRANT REASSESSMENT.

- o THE COMMERCIAL PROGRAM IS BEING IMPLEMENTED BY THE CENTERS FOR COMMERCIAL DEVELOPMENT OF SPACE, NOT NASA CENTERS. THE ROLE OF NASA CENTERS IS LIMITED. IT SEEMS UNLIKELY THAT MSFC WILL OBTAIN ANY SIGNIFICANT PROJECT ASSIGNMENTS FROM OCP.
- o OCP IS POSTURING THE VARIOUS CCDS'S TO PROVIDE UP TO FIFTY PERCENT OF THE PAYLOADS FOR THE SPACE STATION.

IN VIEW OF THE ABOVE, IT WOULD SEEM LOGICAL FOR THE MSFC PERSONS WORKING THE COMMERCIAL PROGRAM TO STRONGLY FOCUS THEIR ATTENTION ON SPACE STATION ACCOMMODATIONS FOR THESE PAYLOADS AND ON FACILITATING THE INTEGRATION PROCESS. THE CCDS WILL NEED HELP AND GUIDANCE IN PREPARING PAYLOADS FOR FLIGHT ON A MANNED FLIGHT SYSTEM.

MSFC MICROGRAVITY PROGRAM  
PRIORITIES

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- ACCOMPLISH CURRENTLY ASSIGNED PROGRAM
- ADEQUATELY DEFINE FUTURE SYSTEMS PRIOR TO INITIATING DEVELOPMENT
- REESTABLISH ADVANCED TECHNICAL DEVELOPMENT PROGRAM
- CONTINUE EFFORTS TO INFLUENCE SPACE STATION PAYLOAD ACCOMMODATIONS
- PURSUE ADDITIONAL PRINCIPAL INVESTIGATOR OPPORTUNITIES FOR MSFC SCIENTISTS
- POSTURE MSFC TO BECOME AN EFFECTIVE MICROGRAVITY DISCIPLINE OPERATIONS CENTER FOR SPACE STATION

## GOALS

### MSFC MICROGRAVITY PROGRAM

- DEVELOP A COMPREHENSIVE RESEARCH PROGRAM IN FUNDAMENTAL SCIENCES, MATERIALS SCIENCE AND BIOTECHNOLOGY FOR THE PURPOSE OF ATTAINING A STRUCTURED UNDERSTANDING OF GRAVITY DEPENDENT PHYSICAL PHENOMENA IN BOTH EARTH AND NON-EARTH ENVIRONMENTS WITH EMPHASIS IN THE FOLLOWING AREAS:
  - ELECTRONIC AND PHOTONIC MATERIALS CRYSTAL GROWTH
  - ORGANIC AND POLYMERIC MATERIALS
  - PROTEIN CRYSTAL GROWTH AND BIOLOGICAL SEPARATIONS
- ESTABLISH MSFC AS THE MICROGRAVITY DISCIPLINE DATA CENTER FOR NASA.
- EXPLOIT THE FULL CAPABILITIES OF THE SPACE SHUTTLE AND SPACELAB IN ACCOMPLISHING USEFUL SCIENCE IN THE SPACE ENVIRONMENT.
- PLAY A LEADING ROLE IN DEFINING THE MICROGRAVITY REQUIREMENTS FOR SPACE STATION FREEDOM THAT WILL ENABLE IT TO BE AN EFFECTIVE LONG-TERM FACILITY FOR CONDUCTING MICROGRAVITY SCIENCE AND APPLICATIONS.
- ESTABLISH MSFC AS MICROGRAVITY DISCIPLINE OPERATIONS CENTER SUPPORTING SPACE STATION OPERATIONS.
- THROUGH A PROGRAM OF SPACE RESEARCH AND DEVELOPMENT, FACILITATE THE DEVELOPMENT OF NEW, COMMERCIALY VIABLE PRODUCTS AND PROCESSES.

## ATTACHMENT 5

## Preface

The current MSFC Microgravity Program evolved from innovative thinking and planning done at MSFC in the late 1960's. These early visions led directly to the establishment of the NASA Materials Processing in Space Program. MSFC stimulated the creation of this program and, for more than a decade, was virtually the only NASA Center involved.

Responsibility for the program in NASA Headquarters changed several times as this program evolved and became the modern NASA Microgravity Program. Program focus in early years was strongly toward applications, specifically aimed at producing in orbit unique products or products superior to those that could be produced on Earth in a 1g environment. As the NASA program matured, the research component was strengthened and the program was broadened, e.g., to include investigations of certain fundamental physical phenomena that could be most effectively explored in a microgravity environment.

Early microgravity materials processing demonstration experiments were accomplished on three Apollo missions. Subsequently, more complex and significant flight facilities and experiments were flown on the Skylab and ASTF missions. To provide flight opportunities during the long period between the completion of the ASTF mission and the availability of the Space Shuttle, MSFC proposed and subsequently managed the ten flight SPAR rocket program. Although the sub-orbital SPAR rocket flights provided only a few minutes of microgravity environment, the program provided experiment opportunities for low cost and enabled the development and flight testing of a number of microgravity materials processing instruments. With the availability of the Space Shuttle, there was a resurgence of orbital flights.

Early flight experiments indicated that effects governing processes in low gravity are often subtle and could easily be overlooked. This led NASA to establish an expanded ground based program including research aimed at more thoroughly characterizing specific processes in an Earth gravity environment to guide the course of future investigations in space. In 1976 MSFC formed a Division in the Space Science Laboratory dedicated to microgravity research. That Division, the Microgravity Science and Applications Division, has evolved and matured as a research organization and is today one of the four Divisions in MSFC's Space Science Laboratory.

The ground based microgravity research program provides the foundation for the flight program. In addition to theoretical and experimental research investigations, experiments utilizing drop facilities and KC-135 flights are included in the ground based program.

The NASA Microgravity Program has emerged from an early period of general concept studies and a few simple demonstration experiments in space to a maturing area of space science involving a variety of flight research investigations. Significant interest in the current NASA Microgravity Program exists in both the scientific and the industrial research communities. Program sponsorship is provided by the Office of Space Sciences and Applications (OSSA) and the Office of Commercial Program (OCP) in NASA Headquarters. In addition to microgravity activities sponsored by OSSA and OCP, the current MSFC microgravity program includes work under the Center Director's Discretionary Fund Program, the Historically Black Colleges and Universities Program, and the Small Business Innovative Research Program.

To date approximately thirty individual microgravity scientific payloads managed by MSFC have been flown on Shuttle/Spacelab missions. These payloads have involved a spectrum of instrument sizes and complexities from simple hand held experiment apparatus to major microgravity processing facilities. In addition, MSFC has had a direct involvement in twenty commercial microgravity payloads flown on the Shuttle.

MSFC played the pioneering role in NASA microgravity research and flight investigations in early years of the program. MSFC should continue to play a leading role in future NASA microgravity activities, both in the area of scientific instruments and flight experiment developments, as well as supporting initiatives of the commercial sector.

## NASA Microgravity Program

The MSFC Microgravity Program and its goals are enveloped within the framework of the over-all NASA Program. The Goals of the NASA Program were stated in the document Microgravity Strategic Plan - 1990 as quoted below:

### NASA Microgravity Program Mission Statement

"The mission of the program is to utilize the unique characteristics of the space environment, primarily the near absence of gravity, to expand man's knowledge of physics, chemistry, materials and fluid sciences, and biotechnology; to understand the role of gravity in materials processing; and, where possible, to demonstrate the feasibility of space production of improved materials that have high technological, and possible commercial, utility."

### NASA Microgravity Program Goals

- Goal 1. "Develop a comprehensive research program in fundamental sciences, materials science and biotechnology for the purpose of attaining a structured understanding of gravity dependent physical phenomena in both Earth and non-Earth environments."
- Goal 2. "Foster the growth of an interdisciplinary research community, united by shared goals and resources, to conduct research in the space environment."
- Goal 3. "Encourage international cooperation for the purpose of conducting research in the space environment."
- Goal 4. "Utilize a permanently manned, multi-facility national microgravity laboratory in low-Earth orbit to provide a long-duration, stable microgravity environment."
- Goal 5. "Promote industrial applications of space research for the development of new, commercially viable products, services, and markets resulting from research in the space environment."

## MSFC Microgravity Program Mission Statement

Develop a Center of Excellence that will lead the Nation in the Development and Exploitation of Microgravity as a National Resource.

### MSFC Microgravity Program Goals

- Goal 1. Accomplish a comprehensive program of research investigations in materials science and biophysics to attain an understanding of gravity dependent physical phenomena.
- Goal 2. Exploit the full capabilities of the Space Shuttle and Spacelab for accomplishing microgravity investigations.
- Goal 3. Play a leading role in the planning and utilization of Space Station Freedom as an international facility capable of effectively supporting microgravity research investigations and applications.
- Goal 4. Establish a world class Microgravity Science Operations Center at MSFC.
- Goal 5. Expand the current ground based program to support the development of future flight apparatus and facilities.
- Goal 6. Serve as a focal point for stimulating industrial interest and involvement in microgravity research and flight projects.

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OF 5000 000000



## MSFC Microgravity Program

### Priorities

- o Accomplish currently assigned program.
- o Continue vigorous ground based research program.
- o Establish "Capability Development" line item to support needed advanced development work for future flight experiments and facilities.
- o Adequately define and properly structure future flight development projects.
- o Pursue additional Principal Investigator opportunities for MSFC scientists.
- o Effectively influence Space Station accommodations to support microgravity investigations.
- o Plan and initiate actions to evolve a Microgravity Science Operations Center
  - Ground Control Experiment Laboratory (GCEL)
  - Microgravity Data Center, Data Repository, and Library
  - Microgravity Discipline Operation Center (DOC)
- o Continue support of the Office of Commercial Program activities, stimulate industrial interest, and encourage private sector investments in specific space activities.

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Discussion of Goals  
of the MSFC  
Microgravity Program

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# Goal 1

Accomplish a comprehensive program of research investigations in materials science and biophysics to attain an understanding of gravity dependent physical phenomena.

As the Microgravity Program has evolved and matured, the focus of areas of scientific research in the MSFC program has sharpened. The current areas of research emphasis at MSFC are coincident within the Branch lines with the Microgravity Science and Applications Division of the Space Science Laboratory.

(a) Electronic and Photonic Materials

(b) Chemistry and Polymeric Materials

(c) Biophysics

A current area of research emphasis in Electronics and Photonic materials is the crystal growth and characterization of type II-VI semiconducting materials with application, for example, as infrared detectors.

The area of chemistry and polymeric materials has received increasing attention of university and industrial microgravity scientists, with the MSFC program having a significant interest in organic crystals and thin films for non-linear optical applications.

The primary emphasis in the Biophysics area currently is Protein Crystal Growth, which is believed to have a high potential for early commercial development.

NOTE: A comprehensive treatment of MSFC's microgravity research activities is contained in the document, Microgravity Research at the Marshall Space Flight Center, published in December 1990 by the Space Science Laboratory. The areas of research emphasis noted above are not inclusive of all current microgravity research at MSFC.

## Goal 2

Exploit the full capabilities of the Space Shuttle and Spacelab for accomplishing microgravity investigations.

MSFC is responsible for a program of microgravity flight investigations on Spacelab missions. The United States Microgravity Laboratory and the United States Microgravity Pallet mission series currently being prepared for flight are dedicated to the microgravity discipline. Microgravity and life sciences investigations will be accommodated on the International Microgravity Laboratory mission series.

Although the Space Shuttle is providing a number of flight opportunities, opportunities are less frequent and transportation costs to orbit far greater than envisioned a decade ago. The orbital environment is not easily accessible. All experiment flight hardware should be well designed and thoroughly tested before flight. In the past the Microgravity Program has encountered some difficulties resulting from overly optimistic development plans for complex experiments and facilities. A thorough project definition phase should precede initiation of development, including building and testing of breadboard hardware where new and challenging instrument concepts are involved. Development projects should be structured to include an appropriate level of reserves for funding, schedule and engineering growth. The required contingencies depend on the complexity and sophistication of the development effort.

The successful management of a Spacelab mission requires an efficient team effort between the Mission Managers, Mission Scientist and Chief Engineer. Successful management of the development of microgravity flight experiment facility requires a team effort between the Project/Experiment Manager, the Project/Experiment Scientist and the Lead Engineer. The requirement for this team effort is now well recognized at MSFC and is functioning. Effective implementation requires continued support by the organizations involved.

### Goal 3

Play a leading role in the planning and utilization of Space Station Freedom as an international facility capable of effectively supporting microgravity research investigations and applications.

The Space Station Freedom will provide the combined features of high power levels, long duration on orbit and a satisfactory quality of microgravity environment to support most investigations. Current microgravity experiments being flown on Shuttle/Spacelab generally will be evolved to fly on the Space Station.

Microgravity materials processing experiments would appear to be able to more effectively utilize the early period of Space Station operations (prior to permanently manned occupancy) than biomedical investigations. To achieve effective use of the Space Station facility for microgravity investigations during unoccupied periods will require innovation in experiment concepts. With the approval of the restructured Space Station Program, it would appear timely for MSFC to intensify studies of microgravity payloads for the Space Station.

Furthermore, MSFC has an important role to play for NASA in influencing the Space Station Freedom accommodations for microgravity research investigations and payloads.

#### Goal 4

Establish a world class Microgravity Science Operations Center at MSFC.

The Microgravity Sciences Operations Center is envisioned as being comprised of three major elements:

- (a) Ground Control Experiment Laboratory (GCEL)
- (b) Microgravity Data Center and Library
- (c) Microgravity Discipline Operations Center (DOC) for Space Station

The MSFC GCEL area should be upgraded and expanded. Its primary purpose is to provide the capability for providing ground control samples processed in flight experiment hardware or equivalent. Also these facilities potentially could be used for other test programs such as breadboard testing, functional testing, development testing, etc., as well as for crew training.

MSFC, particularly the Program Development Organization and Space Sciences Laboratory, have accumulated significant microgravity information and established data bases, including publications by microgravity investigators world-wide. It is suggested that the existing information be expanded into a Microgravity Data Center complementary to the Microgravity Discipline Operations Center (DOC) for Space Station. Flight data would be captured and ultimately archived at the Data Center.

The Space Station Discipline Operations Centers will be directly linked to the Space Station Payload Operations Integration Center (POIC) to be located at MSFC. MSFC is the natural and obvious location for the Microgravity Discipline Operations Center for Space Station.

## Goal 5

Expand the current ground based program to support the development of future flight apparatus and facilities.

This goal is necessary to fill a void in the current microgravity program. Specifically, a "Capability Development" program addition is recommended. The "Capability Development" terminology is adopted from previous usage in OSSA. It is aimed at providing a foundation for development of future flight experiments and facilities.

The OSSA Microgravity Program is perceived to have a solid research foundation based on implementation of peer received research proposals from the scientific community. The over-all program, however, has had serious funding impacts from "over-running" flight projects. What has been sacrificed is advanced development work to support future flight projects. NASA should retain a certain initiative capability to supplement the program foundations emerging from the peer review process. It is recommended that MSFC, along with other Centers involved in microgravity projects, take a pro-active role in stimulating OSSA to establish a "Capability Development" element to the Microgravity Program. Examples of capability development initiatives and areas that are perceived to be needed include the following:

- (a) High temperature furnaces (ampoule design, quenching systems, variable temperature gradients, multiple samples)
- (b) Contactless temperature measurement techniques
- (c) High rate, high resolution video systems

## Goal 6

Serve as a focal point for stimulating industrial interest and involvement in microgravity research and flight projects.

The commercial component of NASA's Microgravity Program has also evolved and matured. Early work in the commercial sector area was pioneered at MSFC dating back to the 1978. A commercial out-reach program was implemented to acquaint the industrial community with the potential attributes of the space processing of certain materials. A number of Joint Endeavor Agreements and Technical Exchange Agreements relating to microgravity initiatives were signed with industry. An Office of Commercial Programs (OCP) was established in 1984 by NASA Headquarters. The Office of Commercial Programs now implements its program through the Centers for Commercial Development of Space (CCDS). The CCDS bring together industry, universities and government research interests in a synergetic environment. Six of the current 16 CCDS are dedicated to microgravity. Several of the other CCDS are also involved in microgravity projects. Microgravity materials processing is highly significant to NASA's Commercial Program.

The MSFC Program Development Directorate has played a significant role in supporting and implementing OCP activities. It appears that a relatively high percentage of Space Station experiments will come from the commercial sector, with a majority of such experiment payloads emphasizing microgravity research. MSFC should continue to provide support to the Office of Commercial activities.



**The MSFC Microgravity**  
**Strategic Plan**

Prepared by  
The Center for Space and Advanced Technology  
In Fulfillment of Contract NAS 8-38669

15 April 1991

## Preface

The current MSFC Microgravity Program evolved from innovative thinking and planning done at MSFC in the late 1960's. These early visions by MSFC led directly to the establishment of the NASA Materials Processing in Space Program. Program focus in early years was strongly toward applications, specifically aimed at producing unique products on orbit.

Early flight experiments indicated that effects governing processes in low gravity are often subtle and easily overlooked. This led NASA to establish an expanded groundbased program including research aimed at more thoroughly characterizing specific processes in an Earth gravity environment to guide the course of future investigations in space. The current NASA Microgravity Program has emerged from an early period of general concept studies and a few simple demonstration experiments in space to a maturing area of space science involving a variety of flight research investigations.

To date approximately 30 individual microgravity scientific payloads managed by MSFC have been flown on Shuttle/Spacelab missions. These payloads have involved a spectrum of instrument sizes and complexities from simple hand held experiment apparatus to major microgravity processing facilities. In addition, MSFC has had a direct involvement in 20 commercial microgravity payloads flown on the Shuttle. A vigorous development program of future microgravity experiments is underway at MSFC, leading the way forward to the Space Station era.

MSFC provided the pioneering role in NASA microgravity research and flight investigations in early years of the program. MSFC will continue to play a leading role in future NASA microgravity activities, both in the area of scientific research and flight experiment development, as well as supporting initiatives of the commercial sector.

## **MSFC Microgravity Program Mission Statement**

***Develop a Center of Excellence that will lead the Nation in the Development and Exploitation of Microgravity as a National Resource.***

## **MSFC Microgravity Program Goals**

- Goal 1.** Accomplish a comprehensive program of research investigations in materials science and biophysics to attain an understanding of gravity dependent physical phenomena.
- Goal 2.** Continue an active program of development of microgravity flight experiments and multi-user processing facilities.
- Goal 3.** Exploit the full capabilities of the Space Shuttle, Spacelab, and Space Station Freedom and effectively utilize available commercial carriers and free flyer opportunities for microgravity flight investigations.
- Goal 4.** Establish a preeminent Microgravity Development Complex at MSFC, including (a) Ground Control Experiment Laboratory (GCEL), (b) Microgravity Data Center and Library, and (c) Microgravity Discipline Operations Center.
- Goal 5.** Serve as a focal point for stimulating industrial interest and involvement in microgravity research and flight projects.

**Discussion of Goals**  
**of the**  
**MSFC Microgravity Program**

## Goal 1

*Accomplish a comprehensive program of research investigations in materials science and biophysics to attain an understanding of gravity dependent physical phenomena.*

As the Microgravity Program has evolved and matured, the focus of areas of scientific research in the MSFC program has sharpened and is directed to specific ground based and flight research investigations. Research emphasis in the Electronics and Photonic Materials area is the crystal growth and characterization of type II-VI semiconducting materials with application, for example, as infrared detectors.

The area of Chemistry and Polymeric Materials is recognized as an increasingly important area of interest for university and industrial microgravity scientists. The MSFC program will continue to develop and provide necessary critical expertise in Organic Crystal Growth and thin films for non-linear optical applications.

MSFC will continue to lead and expand its emphasis in the Biophysics area of Protein Crystal Growth, which has high potential leading to early development of products of great interest to biomedical researchers and pharmaceutical companies.

Diligent efforts will continue to be made to enable the selection of MSFC scientists for Principal Investigator roles for the Microgravity Flight Program and for groundbased research investigations. MSFC scientists will continue and enhance their excellent record of microgravity research publications. Retention and recruitment of highly qualified microgravity scientific talent will receive high priority.

## Goal 2

*Continue an active program of development of microgravity flight experiments and multi-user processing facilities.*

The future microgravity flight program will be based on the foundation being laid by the ground based programs. The orbital flight program will be one of an orderly progression, typically evolving from laboratory research; to experiments in drop facilities, KC-135 aircraft flights, or sounding rocket flights; to experiments on-orbit. Orbital experiments may also follow a progression, e.g., from glovebox experiments, to more elaborate demonstration experiments, to multi-user processing apparatus.

A "Capability Development" budget item will be requested in support of microgravity flight project activities. This will assure that the necessary technology is available for supporting future flight programs.

Thorough project definition phases will precede initiation of design and development. The building and testing of breadboard hardware will be emphasized where new and challenging instrument concepts are involved. Development projects will be structured to include an appropriate level of reserves for funding, schedule and engineering growth.

### Goal 3

*Exploit the full capabilities of the Space Shuttle, Spacelab, and Space Station Freedom and effectively utilize available commercial carriers and free flyer opportunities for microgravity flight investigations.*

The Space Transportation System (STS) is providing a number of flight opportunities, however, access to space is less frequent and transportation costs are far greater than envisioned a decade ago. MSFC is dedicated to continue a quest to identify and design new carrier systems to improve access to space while fully utilizing all current systems such as Shuttle, Spacelab and Space Station Freedom. The goal of MSFC is to provide such capabilities very effectively and timely while maintaining a strong awareness to safety and mission success. New carrier systems sponsored by the commercial sector will be evaluated and utilized fully to meet the Microgravity Program goals and expectations.

MSFC will take a lead role in providing overall management and integration support to the Office of Space Science and Applications (OSSA) in the area of Space Station Science Utilization Management. The evolutionary development of investigator driven multi-user, facility class hardware for microgravity experiments for Spacelab, Spacelab transition and Space Station will be vigorously pursued.

## Goal 4

### *Establish a preeminent Microgravity Development Complex at MSFC*

#### (A) Ground Control Experiment Laboratory (GCEL)

The MSFC GCEL area will be upgraded and expanded. Its primary purpose will be to provide ground control samples processed in flight experiment hardware or equivalent. Also, the GCEL facilities will be used for other test programs such as breadboard testing, functional testing, development testing, etc., as well as for crew training.

#### (B) Microgravity Data Center and Library

The Microgravity Program has accumulated significant microgravity information and established databases worldwide. Such information will be gathered, catalogued and made available in a Microgravity Data Center, complementary to the Microgravity Discipline Operations center (DOC) for Space Station. Flight data will also be archived at the Data Center.

#### (C) Microgravity Discipline Operations Center

A Space Station Microgravity Discipline Operations Center will be developed at MSFC and directly linked to the Space Station Payload Operations Integration Center (POIC) also located at MSFC. This Microgravity Discipline Operations Center for Space Station will direct all microgravity science operations on Space Station.



## Goal 5

*Serve as a focal point for stimulating industrial interest and involvement in microgravity research and flight projects*


The commercial component of NASA's Microgravity Program is continuing to evolve and grow with significant expectations. In support of the Office of Commercial Program and utilizing the established Centers for Commercial Development of Space, MSFC will bring together industry, universities and government research interests in a synergistic environment to promote new products, processes and materials for the private sector.

MSFC will continue to play a leading role in stimulating and facilitating commercial microgravity projects while maintaining a strong sensitivity to the commercial industry's need for quick and easy access to space.

## **References**

1. Marshall Space Flight Center Strategic Plan "Our Future, Our Goals, Our Vision", Spring 1990
2. NASA Microgravity Strategic Plan - 1990
3. "Microgravity Research at the Marshall Space Flight Center", December 1990, Space Science Laboratory, Marshall Space Flight Center

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